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THE PARIS UNDERGROUND.

Inordinately late and behind-hand, like everything else this year in that charming centre of civilization, Paris, the Metropolitan Railway has now gone into operation—not a moment too soon. The Exposition has put back everything, and among American exhibitors this year at crowded Paris, the reassuring phrase "tout de suite," is always interpreted to mean "any time in the next two weeks." But the French arrive, once in a while, and now the Parisians have "got there" with their electric underground long before New Yorkers have. The Metropolitan, which was to have been ready for the Exposition, to relieve the inevitable congestion of traffic, has just started up, and, equipped with American apparatus, is destined to be a great boon to the Parisian public. In fact, it may work out a peaceful social revolution, for the city to-day is at least a quarter of a century behind the times in provision for urban transportation.

One curious observation is that there is a great and even dangerous difference between the temperature of the street and the tunnel, and that many complain of a chill. The difference is said to be as great as thirty degrees. Of course, had steam been used, this would not occur, and it is likely that the same conditions may be reported from London in the new Central underground we are now describing. But it is obviously easy to put that right, and by turning on the electric heaters from June 1 to November 1, the riders in the Paris, London, and New York undergrounds may all be made comfortable and happy.

TREES AND TROLLEYS.

It is acknowledged to be a difficult thing to please everybody, but we must confess a little surprise at finding complaint against the new underground in New York City because the excavations for it are hurting the trees. Hitherto the complaint on that score has lain against the overhead trolley, and it does seem that people might have a little patience with measures specifically intended to dispense with exactly that method of traction. Even if the allegations were true, it would be better, adopting the very arguments of the complainants, to exercise a little temporary resignation and let not only the wires but the whole road get well below the surface.

In this case, the fading away of the trees is not traceable to electricity, because there is no current, and even where there is current, it is not certain that the current kills. On the contrary, scientific agriculturists and arboriculturists are all the time coming forward with learned proof that the current stimulates growth, and that, with enough electricity, you can give to an ordinary maple the girth of a California redwood. The elms up in New Haven have been suffering lately, and it is said that one or two of them supporting trolley wires have received killing shocks. If this be true, it is a criticism merely of the insulation; but the report also comes that the leakage from the gas mains has saturated the ground with gas, thus injurng the roots of the trees with the poison and inducing swift decay. The remedy would appear to be more electricity and less gas.

The statement has recently been made that in Brooklyn, down Fort Hamilton way, some fine, big shade trees have succumbed to the feed wires run through them. This again would imply poor insulation of the feeder cables, and we are inclined to doubt it. But the feeders should be underground, anyhow, and if any trees are suffering from their presence. the reasons for putting them there are all the stronger.

DECORATIVE ILLUMINATION.

In our batch of data this week relative to the Paris Exposition, note is made of two interesting spectacular exhibits, presenting illumination under novel forms. In one of the buildings, the Palace of Optics, some eight or nine hundred vacuum tubes or lights are grouped in one room, to be all lit as a spectacle, and creating a very striking effect. In the other building, the Palais Lumineux, or Palace of Light, the structure is almost entirely of glass, and incandescent lamps are concealed in its hollow members. Here again, as all who have seen it testify, a most charming effect is produced, and a good object lesson is given.

It is rather strange that more use is not made of vacuum tubes, or Geissler tubes, for general spectacular and advertising purposes, for they certainly would attract attention, and would be a variation from the now universal incandescent lamp. It is also rather strange that in decorative work with electric lighting, more use is not made of glass, after the manner of the Palais Lumineux. There is a field here worthy of study by artists in illumination.

THE HUMANE AUTOMOBILE.

During the "record" hot weather of last week, the lower creation suffered equally with human beings, and only too often could suffering or dead horses be seen lying around the streets. When the trolley was being pushed and introduced, it was one of the arguments of this journal and others that its coming would be a great boon to the horse. That this is a mere matter of fact, is shown, for instance, by such a road as the New York Third Avenue, which, during one very hot season when it had 3000 horses, lost 600 of them in a few weeks, and had 300 more in hospital. To-day, with the same system operated electrically, no such scenes of animal distress as were then frequent are possible. There, and on hundreds of other lines, electricity has scored heavily upon the side of humanity, for the street-car service was ever a hard and killing one.

It is now the turn of electricity to emancipate as far as possible from service in the torrid city, the horse of the cab and the dray. It is well to take steps to relieve them as was done last week, but it is better still not to employ them at all. The cruelty may not be intentional in many instances, but it is cruelty all the same; and where the driver, as too often happens, is a brute and a drunkard, the punishment taken by the poor, inoffensive horse in hot weather is something frightful. Let the automobile accomplish further its humane mission by banishing the horse utterly from our streets. Human life itself will then be longer, too.

TRACTIVE ELECTROMAGNETS.

Shortly after the discovery of the electromagnet it became evident that if an electromagnet could be made to lift its armature through even a small space, say a quarter of an inch, and then release the same, a continued repetition of this cyclical process, after the fashion of a trembling bell, could be availed of to perform mechanical work by means of various mechanical contrivances, such, for example, as a rack and pinion. The weight to be raised would be lifted, say a quarter of an inch at each stroke, but would not be allowed to fall back at the time when the armature was released. Some of the earliest electric motors were designed and operated upon this principle. We now know that this is a hopelessly inferior method of transforming electric into mechanical energy. At each stroke of the magnet, energy pours into the magnetic circuit, and none of this energy is available for lifting the weight or doing mechanical work. On the contrary, it is nearly all discharged wastefully as soon as the magnet is de-energized, while the energy which is expended in doing mechanical work and in raising the weighted armature appears in the form of a c. e. m. f. in the electrical circuit of the magnet opposing the energizing current. The consequence is that the efficiency of the motor composed of an energized and de-energized magnet is relatively very small, and the motion is, moreover, of a reciprocating instead of a rotary type. Whenever work has to be done in the way of lifting weights, taking energy from a continuous-current circuit, we now employ an electromagnetic motor in which the magnetic circuit is permanently magnetized and contains a constant stock of energy not requiring replenishment, although a certain small amount of energy has to be expended electrically in maintaining the magnetic energy. By the electromagnetic forces acting on currents in the magnetic circuit of this motor we obtain, as is well known, an efficiency that in large motors is not very far from the ideal 100 per cent.

Special cases may, and occasionally do, arise, however, in which the tractive magnet has to be employed either for lifting, or for working on a small scale. Under these special circumstances it is important to determine the limitations of the method and the best disposition of the parts for the purpose in view. It is to this inquiry that Prof. Goldsborough's elaborate article in this issue is directed, and an analysis is presented of the various and somewhat intricate relations which exist in the design and use of the tractive electromagnet.

RECORDING TELEPHONES.

The subject of recording telephones has always had an interest for many people, and the Poulsen telegraphone, which has already been noted more than once in these pages, is certainly among the features of the Paris Exposition in the electrical section. It is essentially a recording telephone, but instead of the ordinary receiver there is an electromagnet between whose poles a steel strip passes at a uniform rate, moved by clockwork. Variations in the current produce variations in the magnetic field and in the transverse magnetization of the band. On repassing the strip between the poles of the same magnet, and inserting a telephone receiver in the circuit, the original sound is reproduced. This appears very pretty and simple, but in reality the apparatus is most delicate of adjustment, and when last reported upon by our correspondents was not in condition at the Exposition to do any actual or continuous work.

There are other ways, of course, of attaining the result besides spinning out several miles of sensitized telephone diaphragm, and our contemporary, the London *Electrician*, notes a recent one that has come under its notice. The inventor makes use of the ordinary phonograph, adding to it only a loud-speaking telephone receiver in place of the usual receiving diaphragm. This attachment is a large two-pole receiver with a strong magnet of elliptical section similar to that of the two-pole Bell receiver, but larger. This is enclosed in a brass cylinder. A thick tin plate serves as a diaphragm, clamped with a brass drumhead. Attached to the centre of the diaphragm is a short, stiff wire terminating in the centre of a mica diaphragm, to which it is also rigidly attached. A brass eyelet is let into the middle of the mica diaphragm, and the cutting stylus is connected to this by a simple chain link. The stylus is hinged, and a hinged brass flap, to which the fulcrum of the stylus lever is attached, acts as a weight, pressing the point against the wax cylinder and compensating for any inequalities in the surface. This arrangement, when used with an effective transmitter and four good Leclanché cells, reproduces sounds loudly, and traces a record on the phonograph cylinder deep enough to actuate the ordinary speaking diaphragm; but the articulation is said to be most indistinct.

This would appear to be the state of the art at present, though Mr. Edison may have something up his sleeve, while Mr. Berliner's flat disks in the gramophone would seem to offer some possibilities. But the question remains, whether the invention is needed badly enough

to make a profitable demand for it; while there is the further question whether it can be made a practical attachment for the existing telephone. So far, telephone exchange managers have resisted and resented any efforts to add to the apparatus installed at the subscriber's station, even if it be a sanitary mouthpiece, and up to date they have been tolerably successful. If there were a practical recording device, they would probably let it go on for an extra charge, but they all seem very sceptical thus far. Meantime, another recording device, the beautiful Gray telautograph, which was to supplement the telephone, remains in obscurity, perhaps from lurking imperfections, possibly because it is not wanted urgently enough just at present.

ON RATIONALIZING ELECTROMAGNETIC UNITS.

In view of the approaching meeting of the International Electrical Congress at Paris next month, it seems timely to consider the proposals that have been made at different times in the direction of reforming the existing system of electrical and magnetic units and the possibilities of their introduction. The British Association for the Advancement of Science introduced the present centimetre-gramme and second system of units about thirty-five years ago. No one can deny that it was an excellent piece of work and a credit to the committee. The C. G. S. system of units is consistent and accurate, and has stood the test of time satisfactorily.

Although no criticism has been urged against the C. G. S. system in regard to its accuracy or coherence, considerable criticism has of recent years been offered to it on the ground of not being the simplest or most natural. It is evident, by way of analogy, that we might adopt a system of measurement, in which having chosen the unit of length, say a yard, the unit of area might be selected, not as a square yard, which would be the simplest and most natural unit, but as the area of a circle a yard in diameter. In such a system, which might otherwise be quite consistent and accurate, we might expect to find the ratio π to appear with considerable frequency in dealing with square areas, although it might not appear in dealing with circular areas. Since square areas are more commonly met with in practice than circular areas, the balance would be a disadvantage in the adoption of such a system. In a somewhat similar manner, the fundamental entity of the electromagnetic system is a quantity of magnetism imagined to be concentrated on an ideal point-pole and producing a mechanical repulsion upon a similar point-pole at a distance, the whole system being erected upon this basis; whereas, it has become slowly apparent through time and development that a unit pole is most naturally one which produces and emits unit flux of force instead of the unit acting on its prototype with unit force at unit distance. This is entirely in conformity with the modern tendency to account for phenomena in space by modifications in the medium, rather than by some "action at a distance."

The change involved by thus altering the fundamental elements of the C. G. S. system would affect its every department. It would have the advantage of making the system simpler to understand, easier to teach and to remember. It would also simplify some equations and eliminate certain apparent inconsistencies. For example, the magnetomotive force of a coil would be the current-turns simply, instead of the current-turns multiplied by 4π. On the other hand, the constant 4π would make its appearance in certain spherical problems to which it more naturally pertains, and in which no such constant at present appears. On the whole, however, it would seem that a considerable balance of improvement would be effected. Unfortunately, the change would effect every concrete unit we possess except the erg, dyne, joule and watt. The ohm, volt, ampere, farad and henry would all be changed in magnitude to correspond. It is true that they would be changed by precisely known amounts, but the change would involve very awkward multipliers. The change would not benefit the purely practical men. Station managers, salesmen, practical men of all kinds would be subjected to the bother of changing all their working magnitudes for no direct benefit that they could appreciate or perceive. The benefit would be gained by students, physicists, designers, theorists and all who have to use electromagnetic equations and formulæ; and just to the extent that they use such formulæ would their benefit accrue. The change would necessitate governmental action in most civilized countries, since the present units have been legalized or adopted by the principal governments. It is highly doubtful whether the governments could be induced to make the change, even if the Electrical Congress were to adopt the rationalized system pure and simple. All that International Electrical Congresses could achieve would be to agree upon a rationalized system, give it the weight of their authority, and influence their respective governments in favor of the new units. The condition would be something similar to that which now exists in the United States and Great Britain, where the metric system of weights and measures is, and has for some years been, used by scientific men generally, while the governmental adoption of the metric system is, in reality, yet a thing of the future.

It is not reasonable to expect that an International Congress would agree upon this change. It could probably only be effected after the rationalized system had become so generally recognized an improvement that it would be taught in technical colleges to the exclusion of the present system, and even then it is doubtful whether any Congress would recommend the abolition and complete renovation of the concrete electrical units now existing. Within a recent period, however, Prof. Fessenden has suggested a compromise upon the situation. This would entail a change in the values of the units of permeability, magnetic pole, quantity of magnetism and magnetic difference of potential. As, however, these units have not been adopted by any International Electrical Congress as forming part of the practical system, such a change would not interfere with past legislation. It would affect the rationalization of the principal formulæ with which the practical electrician has to deal, but would do so at the expense of making the "permity" or ratio of magnetism to force, 4π times as great as it is at present, so that the permity of air-gaps would no longer be unity but 4π, and the permity of iron would be 4π times greater than it is at present. The rationalization would not be so complete nor simple as if carried out on the Heaviside plan, but the existing concrete magnitudes would be saved. No serious criticisms have yet appeared upon this suggestion as to the truth of its claims.

Dr. Budde wrote an interesting letter upon the proposal, which appeared in our correspondence columns for April 28. In this letter, Dr. Budde seems to think that there is no escape from the π eruption, because there is a 4π which comes into formulæ through surface integration over a spherical surface, and a 2π which comes through line integration around the circumference of a circle. We think, however, that if the surface integral 4π can be taken out of straight-line problems and restricted to spherical problems, where it naturally belongs, the 2π will give no trouble; it also will only appear in circle problems to which it naturally belongs. The way is open, therefore, for a practical solution of the 4π difficulty by the adoption of the Fessenden suggestion, which will simplify our electromagnetic formulæ without altering our ohms, amperes, volts, coulombs, farads or henrys. The cure will not be so complete as if the radical Heaviside method were adopted, but is the only compromise that is at all practicable. We hope that the matter will receive careful consideration at the hands of the Paris Electrical Congress, which is soon to meet.

Electricity Exhibits at the Pan-American Exposition.

The Electricity Building, the construction of which is well advanced, is designed to contain exhibits of electrical apparatus and appliances which have been developed in this country in recent years. The architectural design of this building, as our readers will remember, is that of the Spanish renaissance, while its size is 500 ft. by 150 ft., covering an area of approximately 75,000 sq. ft. This building adjoins the Midway, and will be readily accessible to the many visitors in that section of the Exposition grounds. At the eastern end of the building, and slightly removed from it, stands the Electric Tower, 375 ft. high, which forms one of the features of the Exposition. The illumination of this structure will be one of the most attractive features of the night electrical display.

We are informed by Prof. G. F. Sever, superintendent of exhibits, that the arrangement of the exhibit space in the interior of this building provides for the location of three classes of exhibits. The first class will consist of what is known as the service plant, which is a transforming station of approximately 5000 horse-power. In this plant there will be large static transformers for the purpose of stepping down electrical power derived from Niagara Falls, from 11,000 to 1800 volts, the latter potential being that which is used for distributing power about the grounds for lighting and other purposes. The service plant will be located in the northwestern side of the building, and its construction and installation will afford excellent opportunities for observing the latest practice in sub-station engineering.

The second class will comprise what is known as the collective exhibits, these consisting of electrical apparatus of historical interest, illustrative models or practical contrasts, which show important improvements in the art. In the third class it is proposed to include exhibits possessing distinctive merit; electrical apparatus which possesses excellent workmanship, decided novelty, or is available for useful applications.

This classification has been decided upon as the outcome of study and observation of other large expositions. The authorities of the present Paris Exposition decided at its inception to make it a "selective" exposition. By doing this, it was realized that the warehouse type of exhibits could be avoided, and that the best of the world's products could be obtained. Due to the lessons drawn from the Paris and other large expositions, the selective idea has been adopted for the Pan-American Exposition. The Electricity Section of the Exposition particularly lends itself to this idea. The promotion period of electricity has, it is thought, practically expired, for the reason that much apparatus that formerly was novel, has become familiar to all, and the general designs throughout electrical engineering are practically the same; moreover, the general public is not interested in the endless duplication of articles composing an exhibit, and this is particularly true of electrical devices.

In order to secure the best results with the selective idea in mind, the electrical manufacturers are requested to exhibit such articles and combinations of articles as may be considered novel or of important interest. Where it is necessary to make the contrast stronger, historical apparatus may be introduced, together with the most recent developments. Another important factor which has necessitated a selective exposition in this particular instance, is the small amount of exhibition space, as compared with the area occupied by the buildings. In the Electricity Building, approximately 33 per cent of the ground area is available for exhibit space.

One of the most important features of an exposition is the classification of exhibits. By means of this, the exhibits are arranged and the awards made. After a careful study of the various classifications adopted for other expositions, the following arrangement has been tentatively selected for the Electricity Section of the Pan-American Exposition:

Division—Electricity and Electrical Appliances: Group 1—History and Literature of Electric Science. Group 2—Apparatus Illustrating the Phenomena and Laws of Electricity and Magnetism. Group 3—Apparatus for Electrical Measurements—Laboratory and Commercial. Group 4—Electric Batteries. Group 5—Dynamo-Electric Machinery and Apparatus for the Transmission, Conversion, Distribution and Regulation of Electric Power. Group 6—Electric Lighting. Group 7—Electric Telegraph and Signals. Group 8—The Telephone and its Appliances. Group 9—Electro-metallurgy and Electro-chemistry. Group 10—Electric Heating Apparatus. Group 11—Electro-therapeutics. Group 12—Miscellaneous Applications.

This classification indicates that the history and literature of a subject should be approached first, with experimental science next, and the engineering features as the last element. There is much valuable historical matter in the form of records and drawings, which might be shown under the first group, and it is desirable that these should form elements of the historical or collective section. As showing the developments in electrical measuring instruments for both laboratory and commercial use, it is desired to procure types of all the important apparatus that has been developed during the last seven years. This is considerable in amount, and the refinements which have been introduced in American instruments have made them the standards of the world.

The classification of this section of the Exposition, as outlined above, affords the opportunity for illustrating all the important branches of the art. If all the electric manufacturers will show one of more features of their products, the electrical section of this Exposition should be the most complete that has ever been organized. The instructive, as well as the spectacular side, will not be surpassed by any other exposition's electrical section, and by dispensing with the endless duplication of similar apparatus, the inspection of the exhibits will be accompanied by special interest and the absence of fatigue.

Opening the Paris Electric Underground.

For some time past the opening for service of the first section of the Paris Metropolitan Railway has been eagerly expected, and now a despatch from that city of July 20 says: On the first day of the opening of the Metropolitan Railway, 30,000 persons traveled underground between the Porte Maillot and Vincennes. Of these, five thousand went first class. Many complain of the great difference in temperature noticeable on leaving the street overhead for the railway tunnel, where one is in danger of a chill.

Paris has hitherto been one of the most backward cities in the world as regards transportation facilities, but now possesses an underground metropolitan electric railway similar to that in London.

The line will be a great facility to foreigners, as it crosses the centre of Paris. It starts at the Porte Vincennes and runs just north of and parallel to the Seine, under the Rue de Rivoli, the Place de la Concorde, the Avenue des Champs Elysées and the avenue de la Grande Armée to the Porte Maillot, the entrance to the Bois de Boulogne.

The journey takes a half-hour, as compared with an hour by the street cars. The fares are three cents for second class and five cents for first class passengers. Trains run every ten minutes. They are made up of an electric locomotive and one first class and two second class cars, which are well lighted, as is also the tunnel in which the tracks are laid. The road was inaugurated without ostentation and even without the knowledge of many Parisians.

The railway now opened for working is only a section of a great underground system of rapid transit contemplated by the law of March 30, 1898. It does not exceed 8½ miles in length, and in that distance has 25 stations. In the whole system there will be 39 miles of rail, with 127 stations. It is estimated that the city of Paris will pay $40,000,000 for the sub-work, apart from the superstructure, which is to be paid for by the company having the concession. According to the various natural conditions, the depth of the tunnel's top from the street level ranges from some sixteen feet to such proximity that the wood paving is almost directly supported by the roof, as in the Rue de Rivoli. The electrical apparatus has been furnished by the Westinghouse Company.

Germany Buying American Telephone Patents.

A special despatch from Chicago, of July 20, says: The German Government has paid $350,000 to the Strowger Automatic Telephone Exchange of Chicago for the patents and rights to manufacture and use the company's automatic system. A trial of the apparatus was made in Berlin last January, when the first payment of $150,000 was made. The contract was for a 200-instrument exchange in the government service, to be used six months, and if it proved satisfactory at the end of that time, $500,000 was to be paid for control. At the expiration of the second month the government asked for an extension of the terms of the contract to permit the installation of 200 more automatic instruments in private offices, banks and factories of Berlin.

Central London Underground Railway—II.

NOTTING HILL SUB-STATION.

WHILE there is a rotary converter installation at the power house it will answer the present purposes better to proceed next to describe the electrical equipment of the Notting Hill Gate sub-station. The three-phase, 5000-volt cables enter the sub-station and are brought through double-break Parshall, three-

FIG. 1.—SHEPHERD'S BUSH RAILWAY STATION.

pole, aluminum-bladed switches to the three high-tension bus-bars, which cap all the five high-tension panels. Two of these five panels are devoted entirely to the high-tension feeder switches, through which, as already mentioned, the current is led to the high-tension bus-bars, while each of the other three carries the high and low-tension switches—that is, primary and secondary, respectively, of two transformers.

STATIC TRANSFORMERS.

The static transformers, each of which has a capacity of 300 kilowatts, are of the air-cooled type, being arranged for forced ventilation. The primary coils are wound for 5000 volts, and the secondary coils for 330 volts, the transformers being connected in delta. The core is built up of laminated iron .014 inch thick, arranged horizontally, and forming a double magnetic circuit round the coils; each sheet is japanned separately to reduce the eddy current losses to a minimum. The iron used is of a special quality, having high permeability and low hysteresis loss, and is not subject to deterioration due to ageing. Ventilating ducts are left between the laminations at intervals of a few inches. The coils, which are form-wound, are arranged vertically, there being four primary and four secondary sections. Earth shields are placed between the primary and secondary sections, and ventilating ducts are left to admit of the maximum cooling surface for the coils. The method of cooling by forced ventilation consists in drawing air through the transformer by means of blowers. The air is admitted either at the top of the transformer down through the vertical ducts between the coils, or from one side through the horizontal ducts of the core. The amount by each path can be regulated by means of adjustable dampers situated at the top and side of the transformer case.

The case of each transformer is connected through the base to an air chamber running under the bank of transformers, and the air

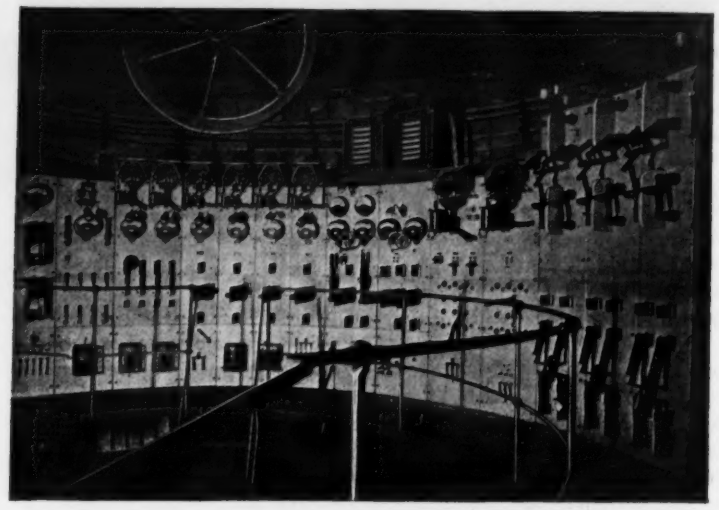
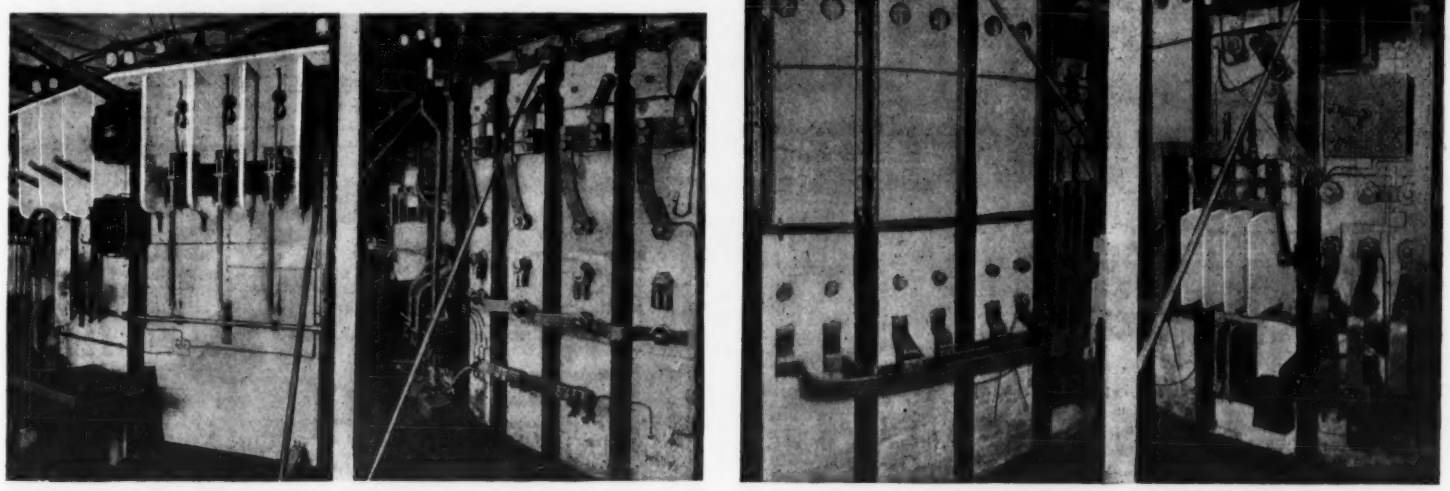


FIG. 3.—NOTTING HILL GATE SUB-STATION—MAIN SWITCHBOARD.

from this is exhausted by means of two blowers furnished by the Buffalo Forge Company and driven by three-phase, induction motors of 6 horse-power, having squirrel cage armatures. Either or both blower sets can be used; but one is sufficient for ordinary needs, the other being held in reserve. Both primary and secondary coils of the transformers are connected to double-pole switches on the switchboard, so that any or all of the transformers may be used as circumstances require.

At each sub-station the secondaries of the six transformers are brought by means of their six independent switches to three main bus-bars, which lead to the top terminals of each of the two 2000-ampere, Samuelson, quick-break switches seen upon the two panels immediately to the left of the transformer panels. These two panels are devoted to the alternating-current side of the two 900-kw rotary converters. These switches handle 2000 amperes per blade, at 330 volts, and have to be protected by marble division slabs. From their



H. T. FEEDER PANELS. L. T. FEEDER PANELS. TRANSFORMER PANELS. CONVERTER PANELS.

FIG. 2.—BACK VIEWS OF SWITCHBOARD, NOTTING HILL GATE.

bottom terminals, leads are carried down under the floor to the brush holders for the collector rings of the rotary converters.

Next it will be convenient to consider the rotary converter, afterward returning to the switchboard.

ROTARY CONVERTERS.

The rotaries are 12-pole, 3-phase, 25-cycle, corresponding to a speed of 250 r. p. m. Each has an output of 900 kilowatts at 500 volts continuous current, the alternating-current input voltage corresponding to this being 305 across the collector rings. The base, a cored-iron casting, is in one piece, and on this are bolted the bearing pillow blocks, the magnet frame and collector brush rigging brackets. The magnet frame or yoke is of mild cast steel, in two halves, belted together, and carries the 12 inwardly projecting magnet cores and pole-pieces, which are laminated sheet steel. The field coils are wound on sheet iron spools, having brass flanges. The winding space on each spool is divided; the upper portion being devoted to the shunt winding, which consists of 912 turns in series of No. 11 B. & S. per spool, while the lower portion is reserved for the series winding. This series winding consists of 8 copper strips, 2.5 in. x .075 in., in parallel, there being 2½ turns per spool. The object of this compounding is so that the rotary may be adjusted to automatically maintain constant voltage under all conditions of load by means of phase control.

Nominally a rotary converter has a fixed ratio of voltage between collector and commutator, but the voltage between the generator and rotary collector ring may be varied by displacing the phases of current and e. m. f., causing the current to lead or lag, as higher or lower voltage of commutator may be required. This is only the case if reactance arrangements be introduced, but in practice, unless extreme variations are required, sufficient reactance exists in the armature of the generator itself, and the leading currents in its armature,

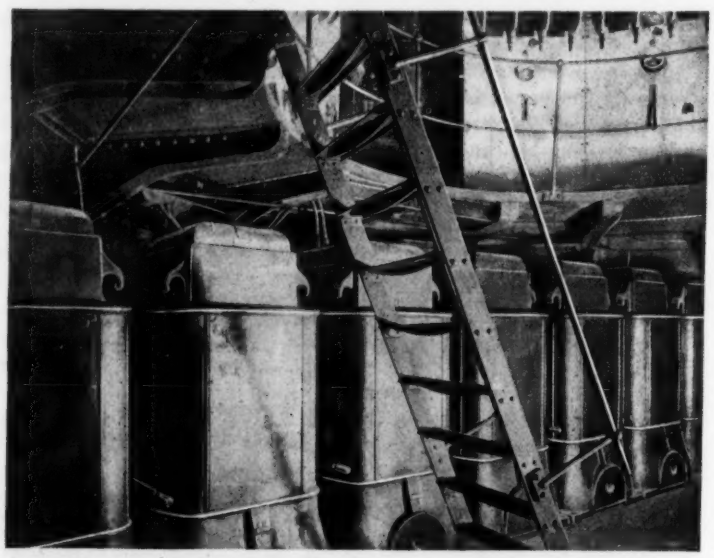


FIG. 4.—BANK OF 300-KW TRANSFORMERS, NOTTING HILL GATE.

produced by the overexcited rotary, help the field excitation, and considerable variation of voltage may be obtained.

Thus, suppose in this case a heavy load comes on, the field becomes overexcited, by reason of the increased ampere turns due to the series winding, and causes the alternating currents to lead in phase, with a corresponding higher voltage at the commutator. The compounding has been so adjusted, by shunting part of the series amperes that the continuous-current voltage keeps quite constant, even under the most trying fluctuations of load.

The outside diameter of the magnet yoke is 123 ins.; the length parallel to the shaft is 22 ins., and the magnetic density in the steel 48,000 lines per square inch. The magnet cores are 12 ins. square, and the length of the pole arc 15⅞ ins.; the density in cores is 95,000 lines per square inch.

The armature core, which is slotted to receive the winding, is built up of separately-insulated, sheet-iron punchings, .014 in. thick, and is carried on a heavy cast-iron spider, the laminæ being secured thereto by dove-tailing. The magnetic density in the teeth is 128,000 lines per square inch, and in the core below teeth, 51,000 lines. The winding is of the multiple-circuit drum class, bar-type construction being employed. There are four conductors, each .4 in. x .125 in. per slot, the dimensions of the slots being 1.25 in. deep x .44 in. wide, and 288 such slots altogether. The number of parallel paths through the armature is 12, leaving 48 turns in series between brushes. The cross-section of these 12 paths is .6 sq. in., and, figuring on the resultant current, gives a current density of 2400 amperes per square inch.

Into this winding are 18 equidistant tappings for the three-phase currents, or three tappings per pair of poles, which are brought down to the three collector rings carried on a separate spider on the shaft. The collector is 24 ins. diameter, and each ring is 3½ ins. wide, and has eight copper gauze brushes, which are supported on cast-iron brackets bolted to the base.

The commutator is 54 ins. diameter and 17½ ins. long, and has 576 segments, or one segment per turn. It is supported by a separate cast-iron spider. There are 12 sets of carbon brushes, each set having eight brushes, 1¼ ins. wide x ¾ ins. thick, and they are carried in holders on spindles fixed to brackets on a cast-iron ring. This ring is supported on arms bolted to the magnet frame, and is free to

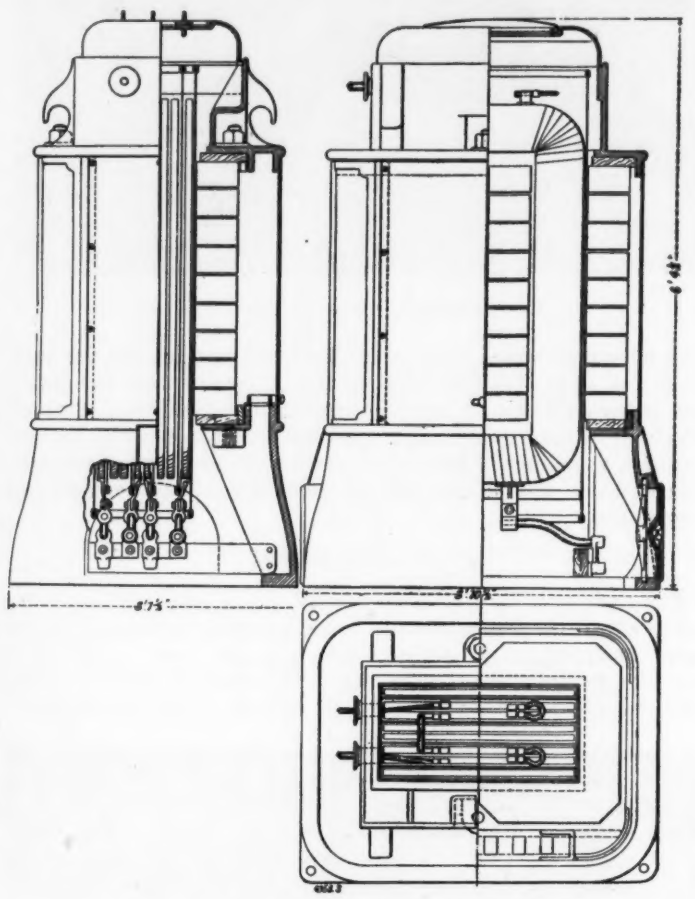


FIG. 5.—SECTIONS AND PLAN OF TRANSFORMER.

move in a groove turned in these arms. By means of a hand wheel and worm, this ring, carrying all the sets of brushes, can be rocked round to any position, but in actual operation for all loads the brushes remain fixed at the mechanically neutral position.

SUB-STATION SWITCHBOARD.

Returning to the switchboard, we find that the next two panels contain the main switches and instruments for the continuous-current side of the rotaries, one panel being for each rotary. The three large, single-pole, quick-break, divided-blade switches on each panel are the positive, equalizer and negative switches, respectively. The bottom of the positive switch is connected to the series winding, and the top is connected to the positive bus-bar. The latter two switches are double-throw, the lower point connects the equalizer switch to the equalizer bus-bar, and the upper position connects the positive brush ring direct to the positive bus-bar, the rotary then running as a shunt machine. If the positive is closed at the same time then the series winding is short-circuited; but if open, then the series winding is open. The negative

switch when thrown upward—which is its normal running position—connects the machine through the circuit breaker to the negative bus-bar. The circuit breaker is located above the three-phase, rotary switch for that particular machine. The down position connects the machine through the starting rheostat to the negative bus-bar. Above the negative switch is the main ammeter of the Weston shunt type, showing total current going out from the rotary on the continuous-current side. The field switches, which are of the double-pole type, are mounted on the sub-bases of their respective panels, and the field

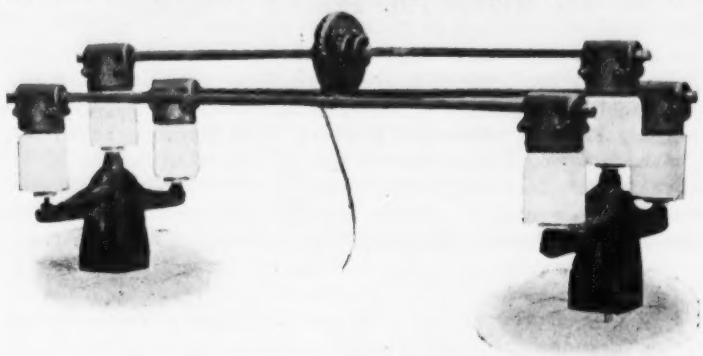


FIG. 6.—CURRENT TRANSFORMER ON BUS-BARS.

ammeter, which reads either way, is mounted to the left of the main ammeter in each case. The field rheostat is mounted above the board and is regulated by means of a hand wheel from front of board with connection board at back. Auxiliary three-pole field switches are mounted on the sub-bases of the three-phase rotary panels, so that when starting up on the alternating current side the field can be divided into four separately-insulated parts, the double-pole field switch also being open. On the sub-base of No. 1 rotary panel, there is the four-point, starting rheostat, one end of which is connected to the bottom terminals of the two negative switches, and the other end to the negative bus-bar. Also, at the top of this panel, there is the alternating-current machine voltmeter, which can be connected across two of the rings on either rotary by means of a plug receptacle on each panel. To the right of the machine voltmeter is the synchronizing voltmeter. The synchronizing lamps are located beside the circuit breaker No. 1 three-phase rotary panel.

Now, follow the four-line feeder panels. The positive bus-bar is continued along the top of these panels, and leads down to each feeder through separate circuit breakers and double-throw, quick-break switches.

The third rail is divided in each tunnel at a point outside each sub-station. This enables the station to feed into any or all of the four sections by throwing the feeder switches in the "up" position. By throwing the switches downward, either or both rails may be made electrically continuous by means of a common bus-bar connecting the lower points of the switches together, and the line can be fed right through by the other stations at work at the time, thus enabling the station to shut down. A Weston, shunt-type ammeter connected in each feeder indicates current going out to each section. The track rails are in permanent connection to the negative bus-bars. The total current returning by the rails in each tunnel is recorded separately by two Thomson integrating wattmeters (one for each tunnel). Mounted on the base of the first of the feeder panels are the two three-pole switches for operating the two 6-hp, three-phase blower motors for the air-blast transformers. On the base of the fourth feeder panel is a double-pole switch and starting rheostat for a series-wound Blackman fan motor for ventilating the sub-station.

The "lift" or elevator panel is next to the feeder panels. There are two positive cables (one in each tunnel) running the entire length of the line. The lift motors at the various stations are connected to these, and in each case use the rail as a return. The cables are brought into each sub-station and connected up to the middle points of the four lever switches, two for either direction. The bottom point connects all cables together and serves to interconnect the separate sections of third rail, so that they may be operated independently of any particular sub-station. The top points of the four switches feed the four insulated sections of third rail, two for each tunnel, each through an ammeter and circuit breaker to the positive bus-bar at the back. Two Thomson integrating wattmeters are mounted on the sub-base of the lift panel, and record the total amount of current going out in either direction to the lifts. It is interesting to note that the ammeter reads either side of zero. The deflection to the left of zero will correspond to the amount of current restored to the line by the lift motors while their individual lifts are on their downward journeys. The lift cables might also act as auxiliary feeders to the line, but are not required for this purpose.

The main lighting and distributing switches are arranged on the next panel. Two positive and two negative lighting feeders run the whole length of the tunnel (one positive and negative in each tunnel). The distributing boards in each station are connected across these, and the whole line is lighted upon the three-wire system. The positive and negative main cables enter each sub-station and are connected through switches and fuses to the positive and negative bus-bars. There are also several battery stations along the line which are also connected across the lighting mains, so that while the sub-stations are running, the lighting can be done from the machines and also charge the batteries at the same time. A minimum cut-out is in circuit, so that should the machine volts drop below the battery volts it acts and throws the lighting load on to the batteries, thus preventing the batteries feeding back into the machine. The batteries are used for lighting the stations, offices and depot during the time that the line is shut down. There are two main switches on the lighting panel, one a single-throw switch, which connects the positive lighting bus-bar to the main bus-bar; the other connects the negative lighting bus-bars to the negative of either rotary (whichever may be running). A main ammeter indicates the total amount of current sent out for lighting. A Thomson integrating wattmeter records the total amount of energy consumed for lighting purposes.

The next and last panel on the board contains various testing instruments. The Weston round ammeter at the top of the panel is for testing the third-rail leakage on any section from either rotary by means of a two-way switch on the sub-base of the panel. Underneath the ammeter is an Elliot recording voltmeter showing drop in volts from certain fixed points along the line to the sub-station. There is also a recording ammeter showing total return by earth to the sub-station.

STARTING AND RUNNING OPERATIONS.

In practical operation the first rotary to be put into service must be run upon the alternating-current side. The switching operations are

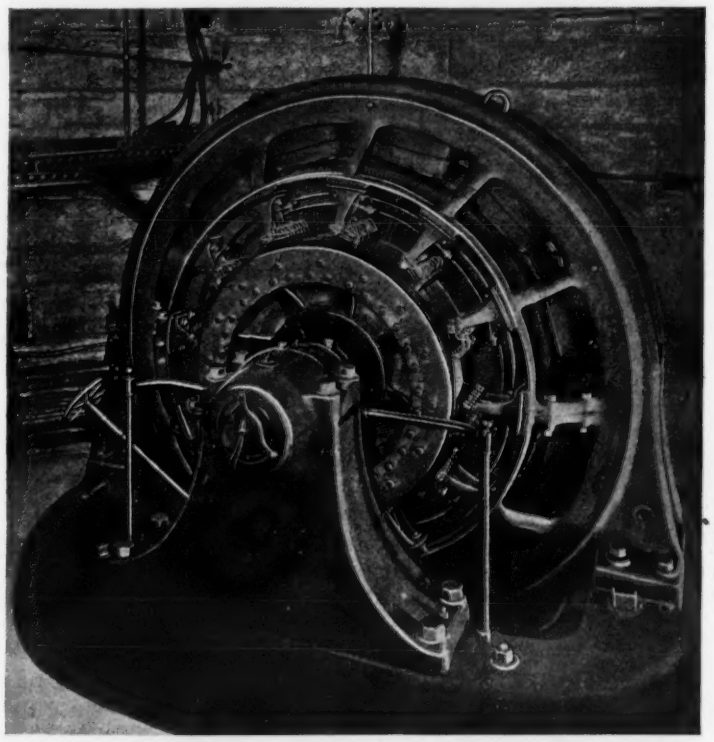


FIG. 7.—900-KW ROTARY, NOTTING HILL GATE.

as follows: The primary and secondary switches of three transformers are closed; one on each of the three transformer panels. The negative switch of the rotary to be run up must be closed, so that the machine will excite its own field when in synchronism. All other switches are left open, including the three-pole field switch, and also the switch in series with the shunt across the series winding. This switch is on the machine frame. The Weston illuminated dial volt-

meter is also connected through to this machine by means of a plug receptacle. By closing the triple-pole, high-tension switch the transformers will be made alive, and by closing the triple-pole rotary switch the rotary will start away, in virtue of induced currents in the pole faces, and of hysteresis. With 5000 volts on the high-tension lines, the rotary starts from rest and runs up to synchronism in about 30 seconds. It requires, however, at the start, about 2000 amperes per collector ring, this being about 200 per cent of full load current. Owing to the many turns per field spool, care has to be taken to open the three-pole, auxiliary field switch. This breaks the field into four sections of three spools each and reduces the induced electromotive force. When synchronous speed is reached, this auxiliary field switch, as well as the main field switch, is closed, and if care is taken to close the switches when the direct-current volts are building up in the right direction (as seen by the voltmeter) the correct polarity may be secured. If, by carelessness, the wrong polarity is given to the machine, the rotary may either be started again or else it may be allowed to run on and the second rotary run up. If this also has the wrong polarity, one may be reversed from the other by the double-pole, reversing field switch shown on the lower panel of No. 2 rotary. The rotary may also be run up from rest with the switches closed through, and then running up the engine slowly.

All the remaining rotaries are started up as continuous-current shunt motors from the line and synchronized in the following manner: If one rotary is already running, in the sub-station, the equalizer switch on the machine that is running is thrown down on to the equalizer bar. The field of the rotary to be run up is made alive by closing the circuit breaker and the equalizer switch downward, and afterward closing the main field switch. The negative switch is now thrown downward and the starting rheostat closed on to the first point. The machine is gradually brought up to speed by taking out resistance and by weakening the field. When the machine is near synchronism, as shown by the synchronizing voltmeter or lamps, the main triple-pole rotary switch is closed and the machine is now running as a synchronous motor. The negative switch is then opened and starting rheostats are opened out for use again. The volts are adjusted to the same as the bus-bar volts, and the negative switch thrown upward. The two machines are now running together in parallel and are dividing the load of the line between them.

If other sub-stations are running at the time and this is the first machine to be started, the equalizer switch is thrown upward; otherwise running-up is performed in exactly the same manner.

FEATURES OF THE SYSTEM.

It will be seen by the various switching arrangements that the sub-station can be run from either or both of the high-tension mains from the power house, and that the switches for the transformers allow either of transformers Nos. 1, 2, 3 to be operated in parallel with transformers Nos. 4, 5, 6, respectively, or will allow the latter set to interchange with the former. A spare transformer is also installed, so that, should it be required, it can be connected in place of any of the other transformers. The rotaries can be operated singly or in parallel either as shunt or compound machines. The switchboard further allows that the rotaries can feed on to either or all of the line feeder and lift cables, so that it is a very unlikely thing for the line or lift to be shut down through breakdown. Furthermore, the lift cable will be of good service for starting up the rotaries on the direct-current side from another sub-station in cases of emergency.

HIGH-TENSION TRANSMISSION LINE.

The 5000-volt current leaves the power house by four independent, lead-covered, three-core cables. These are the National Conduit & Cable Company's paper-insulated cables, tested to 15,000 R. M. S. volts, and, as installed, have undergone a one-hour's test at 10,000 R. M. S. volts between the different cores and from cores to earth. From the power house to Notting Hill Gate sub-station, each core has a total copper cross-section of .1875 sq. ins. The cables, two in the down tunnel and two in the up tunnel, are laid upon cast-iron brackets at the side of the tunnel, and are protected by curved, sheet-iron plates throughout their length. At Notting Hill Gate there is a small brick chamber in each tunnel, within which is mounted a marble connection box. Three 37/16 cables are here carried from the three cores of each of the four cables. These enter the connection box, and may be connected with the ongoing cables or to the sub-station switchboard, or to both. These connections will permit of cutting out of service any one or more of any of the four cables, and of continuing to operate the system over the remaining cables. Moreover, any sub-station may be completely cut off from the high-tension system.

From Notting Hill Gate to Marble Arch, the cross-section of the core is reduced to .125 sq. ins. At the Marble Arch connection boxes, one of the cables in each tunnel is discontinuous. The other two proceed, with the .125 sq. in. cross-section, to the Post Office sub-station, where they are carried directly to the feeder panels without the intermediation of any connection boxes. Here the high-tension line terminates.

The Murray Page-Printing Telegraph.

A group of three patents has been issued to Donald Murray, of New York, and by him assigned to the Postal Telegraph-Cable Company, upon an improved form of page-printing telegraph, employing an ordinary form of typewriting machine. The invention consists in combining a recording instrument having a series of independently-movable character-levers, an electromagnetic perforating instrument, and a tape or strip of suitable material, like paper, which passes through the perforating and recording instruments in succession and providing means for advancing said tape the extent of a section or letter-space at a time through the recording instrument and the extent of a sub-division of such section or letter-space at a time through the perforating instrument. The perforator is connected with either a manual or an automatic transmitter at a distant station by a main-line telegraph wire, and a suitable mechanical actuating device is provided whereby the perforated tape is enabled to operate the typewriter or similar instrument.

At the receiving station the type machine is provided with a series of independently-movable keys, each of which when actuated imprints a letter or character. To operate the typewriter, Mr. Murray employs an actuating device consisting of a series of notched bars or combs arranged compactly in parallel order having a capacity for reciprocating motion, the operating power being supplied by any suitable form of motor, such as an electric motor. These reciprocating combs are controlled by a perforated tape, of paper or other suitable material. The tape is divided into a series of successive longitudinal sections—say one-half inch in length. Each section represents a letter or character and is divided into a predetermined number of elemental parts—say five. Each such sub-division is either perforated or non-perforated. The perforations are arranged in a single right line, and the relative location of one or more perforations in any section determines the letter or character. The tape is moved along section by section—say one-half an inch at each step—across the ends or terminals of the reciprocating combs of the actuator. The actuator operating to press the perforated slip into contact with the ends of said combs forces one, two or more of them to take the desired position, properly aligning the slots in the edge of the combs to permit the immediate subsequent operation of the desired one of the series of type-bars of the machine whereby the letter is imprinted. The transmitter, either manual or automatic, located at the distant station, throws upon the line short current impulses, which operate an electromagnetic perforator at the second station. The tape is fed along through the perforator step by step the length of a sub-division at each step, and the act of perforating and spacing is the result of a single current impulse of either positive or negative polarity.

In operating his system, Mr. Murray employs current impulses that are either positive or negative, separated by a short space or break. At the receiving station there is located an electromagnet, preferably in a local circuit, operated by a neutral relay in the main line. The local magnet operates a pawl taking into the teeth of a wheel located on a shaft carrying a star wheel, the teeth of which are located coincident with the feed holes in the paper tape. The armature of the local magnet is spring-retracted, and a bar carried by it is in position to engage a simple form of paper punch or perforator. There is a finger capable of being projected in and out between the end of the bar and the end of the punch. When this finger is withdrawn, the armature fails to engage with the punch and the paper is advanced one step while the perforator is not operated. This finger or intermediary is controlled by a polarized electromagnet in the main line circuit. A series of makes and breaks of negative polarity operate the step-by-step mechanism, and the paper is fed along without perforating, while one or more positive-current impulses project the finger between the armature and punch and operate to perforate and space the paper. Each current impulse, whether perforating or spacing, moves the paper a single sub-division, say one-fifth of a letter section, *i. e.*, one-half inch. Details of the invention relate to the apparatus and connections for the perforation, etc.

The Design of Tractive Electromagnets.

BY W. ELWELL GOLDSBOROUGH.

IN a series of articles which appeared in the columns of this paper a few years ago the fundamental principles[1] that underlie the economic design of tractive electromagnets were very ably set forth, and I do not wish it to be inferred that I contemplate presenting in this article any radically new matter pertaining to this subject. My effort will be rather to throw some further light on the best methods to be employed in attaining to perfection in the design of this class of electromagnets, and by graphical demonstration to make a mental conception of the principles involved easily acquired.

To bring the subject clearly to our minds I will present again the mathematical proof[2] of the law of maximum work of tractive electromagnets, and incorporate therein a discussion of the effect of magnetic leakage,[3] as this seems to have been a bone for contention in the series of articles referred to.

An electromagnet is made to perform work by placing a loaded armature at a given distance from its poles, and so adjusting it that the armature will be attracted and drawn up to the poles when the exciting coils are energized. Work then, in an electromagnet, we define as the product of the *initial* pull exerted upon the armature by the travel of the armature; and that this product may be a maximum the armature must be placed at such a distance from the poles that the ratio of the rate of change of the magnetic flux in the iron to the rate of change of the magnetizing force producing it is equal to the permeance of the working airgaps.

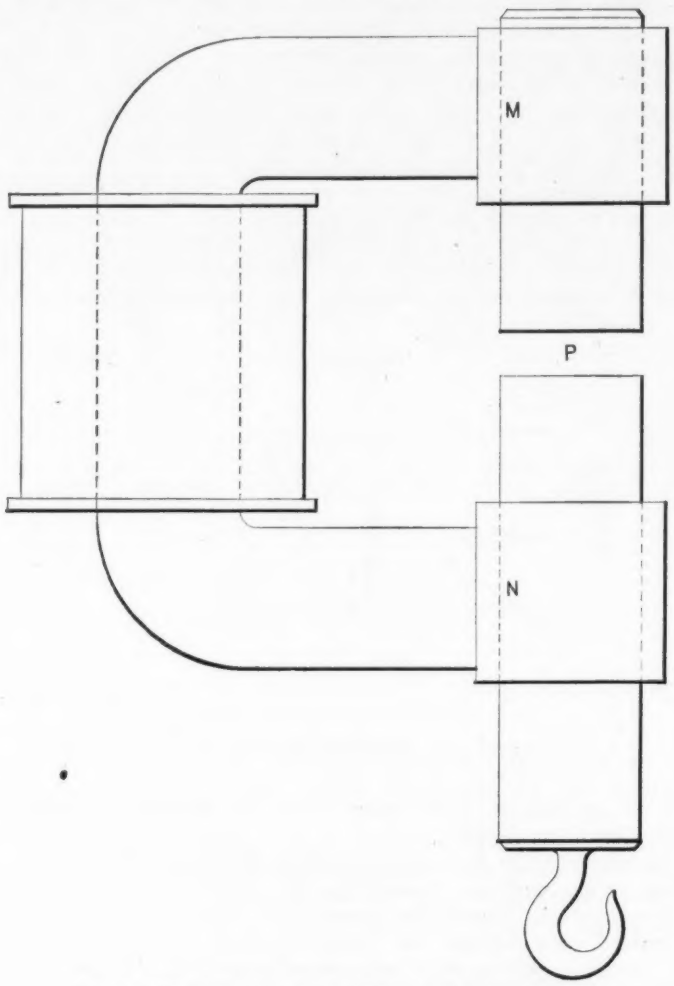


FIG. I.—SIMPLE FORM OF TRACTIVE ELECTROMAGNET.

Consider, as a case in point, the magnet shown in Fig. 1. We have present here all the factors that modify the design of any tractive electromagnet, i. e., variable cross-section of the iron part of the magnetic circuit, airgaps (joints) other than the working airgaps and magnetic leakage. The magnetic density B_c in the core of the exciting coil will be practically constant between the airgaps at M and N, but on account of these and the working airgap at P the flux density B in the poles will be, relatively, somewhat reduced on account of magnetic leakage. If λ is the coefficient of leakage for the magnet, A_c the cross-sectional area of the iron core of the exciting coil, and A the cross-sectional area of the fixed and movable plunger poles M and N, then

$$B A = \frac{B_c A_c}{\lambda} = \phi \qquad (1)$$

Now let L_c be the mean length of the flux path from M to N through the coil (a constant).

L the mean length of the flux path, in iron only, from N to M through the working airgap at P (a constant).

L' the length of the working airgap P (a variable).

L_m the length of the airgap at M (a constant).

L_n the length of the airgap at N (a constant).

H_c the value of "H" corresponding to B_c (a variable).

H the value of "H" corresponding to B (a variable).

H_m the flux density in the airgap at M (a variable).

H_n the flux density in the airgap at N (a variable).

H' the flux density in the airgap at P (a variable).

F' the m. m. f. acting on the working airgap P (a variable).

F the m. m. f. acting on all the circuit except the working airgap P (a variable).

ϕ the total magnetic flux in the working airgap P (a variable).

W the work performed by the magnet, expressed in terms of the product of the initial magnetic pull P' times the length of the working airgap L' (a variable).

A' the mean area of the working airgap at P. We will then have

$$W = P' L' = \frac{A' H'^2}{8\pi} L' \qquad (2)$$

$$\text{and } d W = 2 A' L' H' d H' + A' H'^2 d L' = o \qquad (3)$$

when the magnet is working most efficiently, that is, when the product $P'L'$ is a maximum,

$$2 L' d H' + H' d L' = o \qquad (4)$$

Again, although both F and F' are variables, since they are due to the exciting ampere-turns of the field coil, their sum is a constant, and,

$$F + F' = \text{a constant} = H_c L_c + H_m L_m + H_n L_n + H L + H' L' \qquad (5)$$

therefore,

$$\text{d}(F + F') = L_c d H_c + L_m d H_m + L_n d H_n + L d H + (L' d H' + H d L') = o \qquad (6)$$

and

$$L_c \frac{d H_c}{d L'} + L_m \frac{d H_m}{d L'} + L_n \frac{d H_n}{d L'} + L \frac{d H}{d L'} + H' = o \qquad (7)$$

but from (4)

$$2 L' \frac{d H'}{d L'} + H' = o \qquad (8)$$

and by subtraction of (8) from (7)

$$L_c d H_c + L_m d H_m + L_n d H_n + L d H - L' d H' = o \qquad (9)$$

Moreover we have that

$$\phi = A' H' = A B = \frac{B_c A_c}{\lambda} \qquad (10)$$

and that

$$d\phi = A' d H' = A d B = A_c \left(\frac{\lambda d B_c - B_c d \lambda}{\lambda^2} \right) \qquad (11)$$

Since λ also is a variable; having a different value for each variation of L'; and being a function of all the other variables.

From (11) $$d H' = \frac{A}{A'} d B = \frac{A_c}{A'} \left(\frac{\lambda d B_c - B_c d \lambda}{\lambda^2} \right) \qquad (12)$$

and substituting (12) in (9)

$$L_c d H_c + L_m d H_m + L_n d H_n + L d H - L' \frac{A}{A'} d B = o \qquad (13)$$

and therefore,

$$\frac{A d B}{L_c d H_c + L_m d H_m + L_n d H_n + L d H} = \frac{A'}{L'} \qquad (14)$$

Which is an equation in which the coefficient of magnetic leakage does *not* appear, but which expresses the condition of maximum working efficiency already cited; that the ratio of the rate of change of the flux in the iron to the rate of change of the magnetizing force producing it must be equal to the permeance of the working airgap. The fact, however, must not be lost sight of that "the rate of change of the flux in the iron" (expressed by $A d B$, or more properly by $A \frac{d B}{d t}$, where $d t$ introduces the time element) refers to the *increment* of *change* taking place in the flux density *in the iron* of *the pole faces* about P; so that, where, as in the present case, $A = A'$, the

[1] E. R. Carichoff, *Elec. Wld.*, Vol. XXIII., p. 113 and p. 212, 1894.
[2] Cary T. Hutchinson, *Elec. Wld.*, Vol. XXIII., p. 243, 1894.
[3] P. Matthews vs. E. R. Carichoff, Ibid, p. 776.

condition which obtains is that

$$d\,B = d\,H' \quad \ldots\ldots (15)$$

and that $B = H' \quad \ldots\ldots (16)$

Moreover, remembering that

$$d\,\phi = A\,d\,B \quad \ldots\ldots (17)$$

that $$d\,F = L_c\,d\,H_c + L_m\,d\,H_m + L_n\,d\,H_n + L\,d\,H \quad \ldots\ldots (18)$$

and that

$$\frac{A'}{L'} = \frac{H'\,A'}{H'\,L'} = \frac{\phi}{F'} \quad \ldots\ldots (19)$$

the condition of maximum work is very simply expressed by the equation,

$$\frac{d\,\phi}{d\,F} = \frac{\phi}{F'} \quad \ldots\ldots (20)$$

The significance of the preceding mathematical demonstration will be better appreciated if it is studied in connection with the diagram shown in Fig. 2. In this figure the curve $O\ S\ J$ represents the relative values of ϕ and F, and the curve $K\ T\ I$ the relative values of ϕ and F'. Or, in other words, the curve $O\ S\ J$ is plotted from the values of the total flux in the working airgap and the corresponding values of the m. m. f. impressed upon all of the magnetic circuit outside of the working airgap. While the curve $K\ T\ I$ is plotted from the values of the total flux in the working airgap and the corresponding values of m. m. f. required to force this flux across the working airgap. Now since the total m. m. f. impressed upon the magnetic

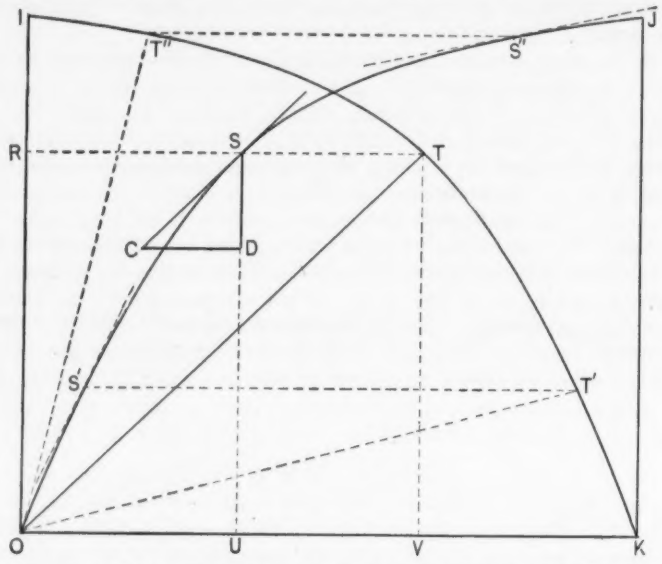


FIG. 2.—GRAPHICAL PRESENTATION OF THE MAXIMUM WORK LAW OF THE TRACTIVE ELECTROMAGNET.

circuit $(F + F')$ is a constant, the sum of the abscissæ of the two curves, taken for successive values of ϕ, will give the straight line $K\ J$. Again, if we draw a tangent to the curve $O\ S\ J$ at any point, as S, its slant will graphically represent the ratio $\frac{d\,\phi}{d\,F}$, since $S\ D$ and $C\ D$ are respectively proportional to $d\ \phi$ and $d\ F$. Likewise if we take the point T on the curve $K\ T\ I$ that has the same ordinate as the point S, and connect T and O, the line $O\ T$ will represent the ratio $\frac{\phi}{F'}$ since $T\ V$ and $O\ V$ are respectively equal to ϕ and F'.

Now, if the excitation remains constant, as the plunger moves up to its seat the points S and T move along the curves $O\ S\ J$ and $K\ T\ I$ towards J and I, respectively, and when they arrive at such positions that the tangent to the curve at S is parallel to a line connecting O and T, the condition expressed in equation (20) is fulfilled and the plunger is in that position which admits of the magnet doing the maximum amount of work. The points S and T will always be opposite one another, as at S' and T', and S'' and T''', and have the same ordinate values.

When the plunger (N) is upon its seat (M), the points S and T will be at J and I, respectively, and the magnet will be exerting its maximum grip upon the plunger or armature. Under these conditions the magnet is capable of sustaining a large and essentially presents all the features of ordinary portative electromagnets.

When the plunger is removed to a great distance from its seat the points S and T will approach the positions O and K, respectively, but owing to the fact that the mean density in the working airgap can never be reduced to zero, they will stop short of the limits, in some position where but a feeble pull is exerted upon the plunger. The action of the magnet upon its armature for points on the curves below the points S and T, as shown, is analogous to the action of an ironclad solenoid upon its plunger, especially where the design follows the lines shown in Fig. 7.

In designing an electromagnet to perform a given number of inch-pounds of work the condition of maximum working efficiency should be met before other modifications tending to greater economy are introduced. Since, however, by properly adjusting the length of the magnetic circuit in the iron, it is possible to design a magnet that will fulfil the conditions above mentioned and use *any* magnetic density in the iron, it becomes at once apparent that the magnetic density employed has a marked influence upon the weight of material required.

Owing to the varying permeability of iron and steel at different magnetic densities, a rather complicated relation exists between the various quantities involved. In any given case, however, the weight of magnetic material decreases with the increase of the magnetic density, however high it is carried, while the amount of copper required for the exciting windings correspondingly increases with the magnetic density. In a magnet designed to perform a given number of inch-pounds of work the cross-section of the iron core will be the smaller, the greater the magnetic density used, but the travel of the armature or the length of the working airgap will increase with the magnetic density. In general it is best to use high magnetic densities where the travel of the armature has to be large, and low magnetic densities when the necessary travel is small.

As a matter of fact, there is but one magnet that can be made with any given material and for definite duty that will have the least weight or the least cost, as the case may be; and if the range of action of the armature of this magnet cannot be suitably adjusted by modifying the shape of the pole pieces, the use of levers should be resorted

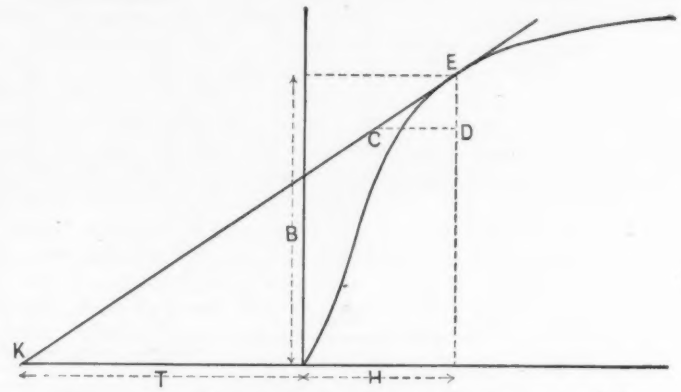


FIG. 3—GRAPHICAL DETERMINATION OF THE VALUE OF $\frac{d\,B}{d\,H}$

to, as any change in the dimensions of the magnet will lessen the economy of its design.

In applying[4] the foregoing principles and considerations to the design of a magnet for specific duty the problem in hand should be broached in the manner that presents it in its simplest form. The essential features having been determined upon, it will be time enough to introduce such modifications as are demanded by the special conditions imposed to which it must be made to conform.

(*a*) As an initial condition assume that the magnetic circuit of the magnet has a uniform cross-section. Then, using the notation established on p. 125 we have that, $A = A_c \quad \ldots\ldots (21)$

Further assume that there is no airgap or joint other than the working airgap in the magnetic circuit. The ordinary horseshoe electromagnet is representative of this type, the effective working range (L') being equally divided between two airgaps and the initial pull exerted by the magnet upon its armature being doubled, the work performed remains the same. In view of these assumptions equations (14) and (20) will take the form,

$$\frac{d\,\phi}{d\,F} = \frac{A\,d\,B}{L\,d\,H} = \frac{A\,B}{(T + H)\,L} = \frac{\phi}{F'} = \frac{H'\,A'}{H'\,L'} = \frac{A'}{L'} \quad \ldots\ldots (22)$$

in which B is expressed in gausses, L and L' in cms., A and A' in sq.cms., and H', H and T in gilberts.

Here (T) is the distance from the point (K), Fig. 3, where the

[4] W. E. Goldsborough, Notes on Design of Electrical Machinery, Part III., p. 9, 1897.
H. B. Smith, Journal of the Worcester Polytechnic Institute, Vol. II., No. 4, 1899.

tangent to the permeability curve at (E) cuts the H axis, to the foot of the B axis, as indicated: its use being allowable, since,

$$\frac{d\,B}{d\,H} = \frac{E\,D}{C\,D} = \frac{B}{(T+H)}.$$

From this it is seen that the permeance of the working airgap must be constant and equal to

$$\frac{B\,A}{(T+H)\,L}$$

whatever the value for L'.

(b) If now the cross-sectional area of the ferric and working airgap portions of the magnetic circuit are made equal, $A = A'$; and L' will have a value, D_0, satisfying equation (22).

Therefore,

$$D_0 = \frac{(T+H)\,L}{B} \quad \ldots\ldots\ldots\ldots\ldots\ldots (23)$$

The maximum work that the magnet will perform with this length of airgap, will be

$$W = P_0\,D_0 = \frac{B^2\,A\,D_0}{2{,}465{,}527{,}680} = \frac{B\,A\,(T+H)\,L}{2{,}465{,}527{,}680} \text{ kilogramme-meters} \quad (24)$$

$$= \frac{B\,A\,(T+H)\,L}{340{,}800{,}000} \text{ foot-pounds} \quad \ldots\ldots (25)$$

where B is expressed in gausses, A in sq.cms., T and H in gilberts and L in cms., as in section (a).

Equation (23) expresses a relation that should be made the first step in the practical design of a tractive electromagnet. The preliminary assumptions should be made from information obtained from successive trials by substitution in this expression; the necessary data for all trials can be taken directly from the permeability curve of the iron to be used. Between equations (23) and (25) we have

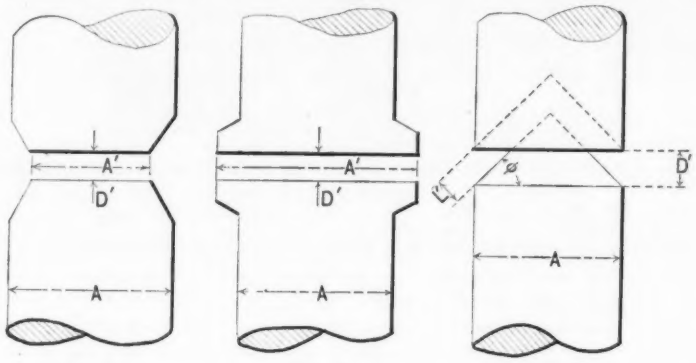


FIG. 4. FIG. 5. FIG. 6.

METHODS OF VARYING THE LENGTH OF TRAVEL WITHOUT VARYING THE RELUCTANCE OF THE WORKING AIRGAP.

therefore a means of quite readily approximating the best proportions to give B, A and L, before taking up the more elaborate details of the design.

(c) If a magnet is desired which will perform an amount of work equal to ($P_0\,D_0$), but work over a range D' by exerting an initial pull P', the conditions can usually be met by so varying the area of the working airgap, relatively to D', that the reluctance of the working airgap will remain constant. Then,

$$W = P'\,D' = P_0\,D_0 \quad \ldots\ldots\ldots\ldots\ldots\ldots (26)$$

and the pull that the magnet will exert over the new distance will be,

$$P' = \frac{P_0\,D_0}{D'} = \frac{B\,A\,(T+H)\,L}{11{,}183{,}460\,D'} \text{ pounds} \quad \ldots\ldots (27)$$

For, let A_0 and B_0 be respectively the area of the airgap, and the magnetic density in the airgap when the pull is equal to P_0, then,

$$\frac{D'}{A'} = \frac{D_0}{A_0} \text{ and } D_0 = \frac{D'\,A_0}{A'} \quad \ldots\ldots\ldots\ldots\ldots\ldots (28)$$

since the reluctance of the airgap remains constant, and

$$B'\,A' = B_0\,A_0 \text{ and } B_0 = \frac{B'\,A'}{A_0} \quad \ldots\ldots\ldots\ldots (29)$$

since the total flux will remain constant. Now,

$$P'\,D' = \frac{B'^2 \times A' \times D'}{11{,}183{,}460}$$

and

$$P_0\,D_0 = \frac{B_0^2 \times A_0 \times D_0}{11{,}183{,}460} \quad \ldots\ldots\ldots\ldots\ldots\ldots (30)$$

$$= \frac{B'^2 \times A'^2 \times A_0 \times D' \times A_0}{A_0^2 \times 11{,}183{,}460\,A'}$$

$$= \frac{B'^2 \times A' \times D'}{11{,}183{,}460} = P'\,D' \quad \ldots\ldots\ldots\ldots (31)$$

by substitution from (28) and (29).

(d) To determine the area of cross-section of the magnetic circuit of a magnet designed to exert a pull of P' pounds over a distance D' in centimetres, we have from (27) that,

$$A = \frac{11{,}183{,}460 \times P' \times D'}{B\,(T+H)\,L} \text{ sq. cms.} \quad \ldots\ldots\ldots\ldots (32)$$

(e) To determine the area of the airgap when it is at right angles to the path of the lines of force in the iron, we have,

$$\frac{A}{D_0} = \frac{A'}{L'} = \frac{A'}{D'} = \text{a constant} \quad \ldots\ldots\ldots\ldots\ldots\ldots (33)$$

therefore,

$$A' = \frac{D'\,A}{D_0} = \frac{B \times A \times D'}{(T+H)\,L} \quad \ldots\ldots\ldots\ldots\ldots\ldots (34)$$

from equation (22). A relation that is shown in Figs. 4 and 5.

(f) To determine the area of the airgap when it makes an angle ϕ at right angles to the direction of the path of the lines of force in the iron.

The condition of constant reluctance remains as expressed in (33), but now, as shown in Fig. 6,

$$L' = D' \cos\phi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (35)$$

and $$A = A' \cos\phi \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (36)$$

Therefore, from (33), (35) and (36)

$$\frac{A' \cos\phi}{D_0} = \frac{A'}{D' \cos\phi}$$

whence

$$(\cos\phi)^2 = \frac{D_0}{D'}$$

and

$$\frac{A^2}{A'^2} = \frac{D_0}{D'}$$

by substitution from (36). By this means therefore we may increase the travel four times by doubling the polar surfaces, or the area of the working airgap. In other words,

$$A' = A\sqrt{\frac{D'}{D_0}} = \frac{A}{\cos\phi} \quad \ldots\ldots\ldots\ldots\ldots\ldots (37)$$

(g) If the magnetic circuit contains airgaps, and joints, other than the working airgap, equation (22) must be expanded and made more nearly to conform to the general expression equation (14), since in this case,

$$\frac{d\,\phi}{d\,F} = \frac{A\,d\,B}{L\,d\,H + L_a\,d\,H_a} = \frac{A\,B}{(T+H)\,L + H_a\,L_a} = \frac{A'}{L'} \quad \ldots\ldots\ldots (38)$$

in which $H_a\,L_a$ is equal to the m. m. f. necessary to force the total flux over all the airgaps and joints other than the working airgap.

(h) If the magnetic circuit varies in cross-section, or if the quality of the magnetic material is changed in any part of the magnetic circuit, (38) becomes,

$$\frac{d\,\phi}{d\,F} = \frac{A\,B}{(T+H)\,L + (T_1+H_1)\,L_1 + H_a\,L_a} = \frac{A'}{L'} \quad \ldots\ldots\ldots (39)$$

where the subscripts (1) refer to that portion of the ferric magnetic circuit where a variation takes place in the permeability in consequence of such change.

If the total length of the magnetic circuit in iron remains constant, then of necessity the value of L in (39) is reduced from the value it has in (38) by an amount equal to (L_1).

(i) If there is an appreciable amount of leakage of the lines of force around the working airgap, the leakage coefficient is *not* introduced into (22) or (39) directly, for reasons already brought out in the discussion of equations (1), (11) and (14); although the formula must necessarily be modified and a suitable correction made. To this end the absolute flux density must be determined for the different portions of the magnetic circuit where variations occur on account of leakage; and the corresponding values of (H), (T) and (L) must then be found and placed in the denominator of (22), in the same manner as (H_1), (T_1) and (L_1) are introduced into equation (39).

(j) A general expression for the area of the polar surfaces of the working airgap of a tractive magnet developing maximum work involves a recognition of all the modifying factors mentioned thus far, and finally, therefore, we arrive at equation (40), which is but another statement of equation (14), in, however, a more useful form, and one obtained by steps already indicated.

$$A = \frac{340{,}800{,}000\,W}{B\,[\Sigma\,(T+H)\,L + \Sigma\,(T_c+H_c)\,L_c + \Sigma\,(H_a\,L_a)]} \text{ sq. cms.} \quad (40)$$

A = the cross-sectional area of the magnetic circuit at points near the working airgap.

W = the work expressed in foot-pounds.

B = the density in the pole pieces in gausses.

$\Sigma\ (T + H)\ L$ is for all portions of the magnetic circuit in iron not subject to leakage.

$\Sigma\ (T_c + H_c)\ L_c$ is for all portions of the magnetic circuit in iron that are subject to leakage, and

$\Sigma\ (H_a\ L_a)$ is for all joints and airgaps in the magnetic circuit except the working airgap, all expressed in gilberts.

Similarly, the general expression for D_0 defined as in equation (23) is

$$D_0 = \frac{\Sigma(T+H)\,L + \Sigma(T_c + H_c)\,L_c + \Sigma(H_a\,L_a)}{B} \text{ cms} \quad \ldots\ldots\ldots(41)$$

A point has now been reached at which the consideration of a practical problem involving an application of the expressions just derived will be instructive. I will therefore cite the final set of calculations submitted by Messrs. C. H. Quinn and E. T. Mug in their report of Design No. 99026, of an electromagnet to perform 350 inch-pounds of work; this design being one of a series completed in the fall of 1898 by the senior class of '99 in electrical engineering at Purdue University.

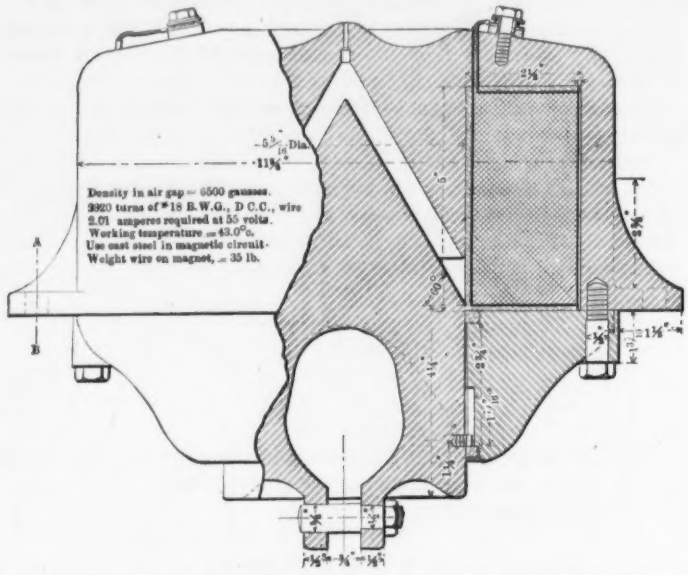

Density in air gap = 6500 gausses.
2920 turns of #18 B.W.G., D C.C., wire
2.01 amperes required at 55 volts.
Working temperature = 43.0°c.
Use cast steel in magnetic circuit.
Weight wire on magnet, = 35 lb.

FIG. 7.—DESIGN OF A TRACTIVE ELECTROMAGNET TO PERFORM 350 INCH-POUNDS OF WORK.

DESIGN OF A TRACTIVE ELECTROMAGNET TO PERFORM 350 INCH-POUNDS OF WORK.

The design must be of the ironclad type, cast steel being the only ferric material used in the magnetic circuit.

The magnet must be so constructed that it can be operated continuously on a 55-volt direct-current circuit and the rise in temperature of the frame be not more than 23° Centigrade above that of the surrounding air.

ASSUMPTIONS.

Assume a uniform area of the magnetic circuit at right angles to the path of the flux in the inner pole piece, the yoke and the outer pole piece.

A leakage coefficient (λ) of 1.30.

Radiating surface taken to include the entire outside surface of the magnet frame, except the outer surface of the inner pole face ($R\ S$, Fig. 9), and the surface of the armature or plunger, which are excluded as not effective. This assumption is allowable, as the exciting coil is to be wound on a brass spool with 1-32 of an inch fibre insulation between the spool and the wire, and conduction of heat will take place from all sides of the spool.

Density in the working airgap, assumed for use in equation (41), taken as 13000 gausses.

Through the medium of two trial calculations, general dimensions of the electromagnet, *about* as given in Fig. 7, were obtained, and based upon these the final set of calculations, that follow, were carried out. The final design, the outcome of the final calculations, is shown in Fig. 7.

Referring now to Fig. 9; with the outline of the magnetic circuit before us, we can intelligently lay out our work. From the disposition of the working airgap ($O\ G$) relatively to the magnetizing coil it is evident that the flux density in the iron will be greatest above ($B\ C$) and that, since λ is given an assumed value of 1.3, the density at this point will be $B_3 = 13000 \times 1.3 = 16900$. It is quite as evident that in the iron above E the density will be but slightly above 13000, and that about H and F it will be, by assumption, 13000; B_1 will therefore have this value at these points, as indicated. Between the points B and H and the points C and E the density will gradually diminish from 16900 to 13000, but for our purposes we may consider that over the distances L_2, as indicated in Fig. 9, the density has an average value $B_2 = \left(1 + \frac{\lambda - 1}{2}\right) B_1 = 1.15 \times 13000 = 14950$ gausses, which is an allowable assumption.

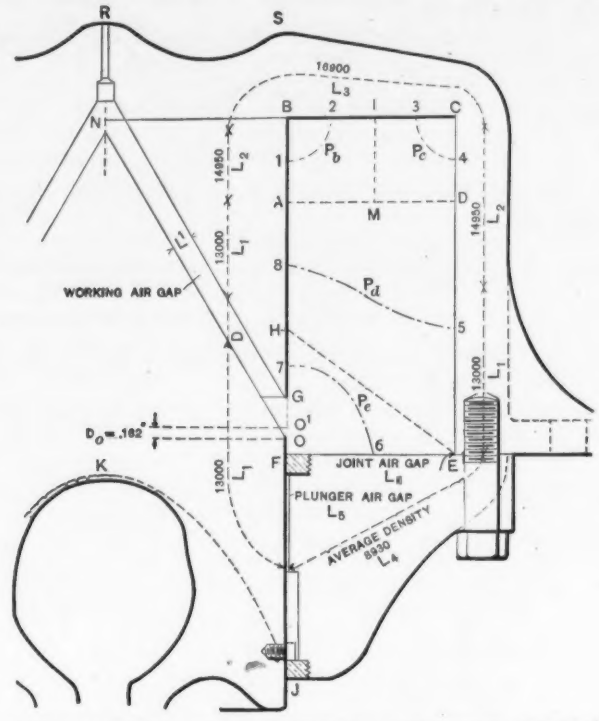


FIG. 9.—THE MAGNETIC CIRCUIT; SHOWING THE USEFUL AND LEAKAGE FLUX PATHS.

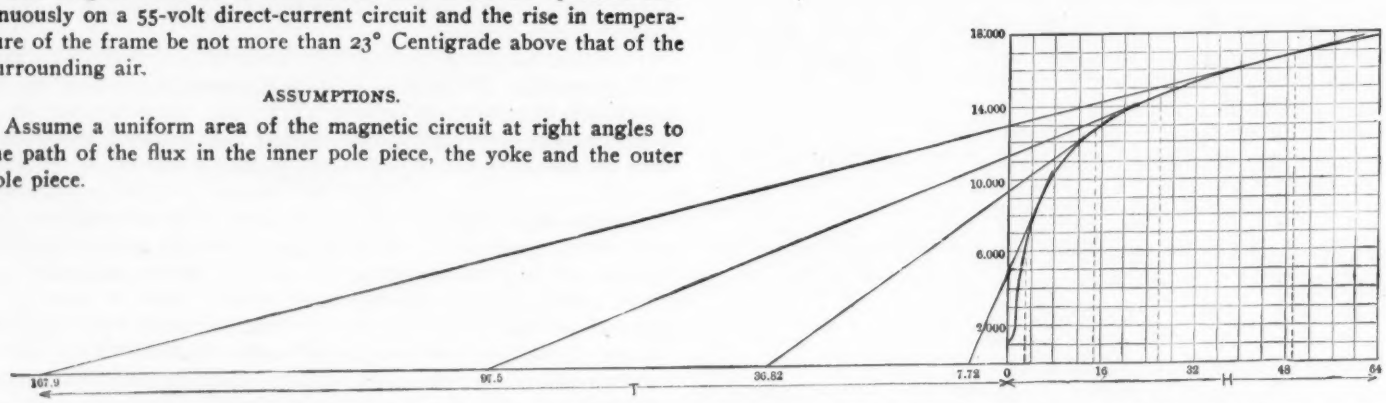


FIG. 8.—GRAPHICAL DETERMINATION OF THE RATIO OF THE RATE OF CHANGE OF THE FLUX DENSITY TO THE RATE OF CHANGE OF THE MAGNETIC FORCE PRODUCING THE FLUX.

Owing to the shape of the coil cap ($F\ E\ J$), there is of necessity a variable density throughout the length of (L_4). In the iron about the joint at (E) the density is 13000. In the iron just outside the brass guide rings J and F, owing to the fact that the cylindrical area here has been increased to nearly three times the cross-sectional area of

the plunger, the density is only 4860 gausses. The mean density in the coil cap will therefore be,

$$\frac{4860 + 13000}{2} = 8930 \text{ gausses.}$$

Since previous trial calculations have shown that the probable best cross-sectional area for the plunger is 22.2 square inches, and since the mean area of the $^1/_{32}$" plunger airgap between the brass rings is $\left(5\frac{5''}{16}+\frac{1''}{32}\right)\times\pi\times 2\frac{3}{4}'' = 50.2$ sq. ins., the density in the plunger airgap will be $\frac{22.2}{50.2}\times 13000 = 5750$ gausses.

We can now determine by actual measurement of the drawing the lengths of the several sections of the magnetic circuit that are permeated by the several different densities as already indicated. The design shown in Fig. 7, in accordance with the preliminary assumptions, has been laid out so that the cross-section of the outer jacket at D at right angles to the path of the flux is equal to the cylindrical area of the yoke through C, is equal to the cylindrical area of the yoke through (B), is equal to the cross-sectional area of the plunger through F; or it has been so designed that the area of the flux path will be a constant at all points except in the coil cap, the plunger gap and the conical working airgap. The mean length of the path followed by the flux will lie approximately in the centre of the outside jacket, in the centre of the yoke and coil cap, and at two-thirds of the radius of the plunger distant from the centre axis of the plunger, for obvious reasons; and from the dotted path of Fig. 9 we can get the necessary data for the several values of L, as this line is so placed. The values of L are tabulated in Table I.

TABLE I.

Subscripts used in Figure 9. (1)	Values of B in Gausses. (2)	Values of H in Gilberts. (3)	Values of T in Gilberts. (4)	Values of L in Inches. (5)	Product of Values in (3) and (5). (6)
MM L_1.....	13000	14.7	36.82	7.50	113
MM L_2.....	14950	26.0	97.50	3.375	87.7
L_3.....	16950	49.0	167.9	4.45	218
L_4.....	8930	5.5	7.72	3.45	190
L_5...	5750	5750.0	0.	.031	178
L_6.....	13000	13000.0	0.	.001	13
D_0.....	13000	13000.	0.	.162	2110.
				Total,	2738.7

Furthermore in Fig. 8 is shown the B and H curve of the cast-steel to be used in making the magnet. From this curve then, as indicated, we can get the values of T and H, by drawing tangents to the curve at points corresponding to the densities $B_1 = 13000$, $B_2 = 14950$, $B_3 = 16950$ and $B_4 = 8930$. These are also tabulated in Table I.

By substitution in equation (41) from Table I, we get,

$$D = \frac{(T_1+H_1)L_1+(T_2+H_2)L_2+(T_3+H_3)L_3+(T_4+H_4)L_4+H_5L_5+H_6L_6}{B} \quad (42)$$

$$= \frac{(36.8_2+14.7)7.5+(97.5+26)3.375+(167.9+49)4.45+(7.72+5.5)3.45+5750\times.031+13000\times.001}{13000}$$

$$= \frac{2106}{13000} = .162 \text{ inches, as the values of } L \text{ were expressed in inches.}$$

Taking this value as the length of the working airgap, the initial pull to be exerted by the magnet is

$$P_0 = \frac{W}{D_0} = \frac{350}{.162} = 2153 \text{ pounds.....(43)}$$

If we have 13000 gausses acting in this airgap, from equation (30) a pull of

$$P = \frac{B^2}{11,183,460} = \frac{\overline{13,000}^2}{11.183,460} = 14.96 \text{ pounds.....(44)}$$

will be exerted per square centimeter of pole face area, and hence the polar area must be,

$$\frac{2153}{6.45\times 14.96} = \frac{2153}{97} = 22.16 \text{ square inches.....(45)}$$

We therefore find (following the line of work indicated in connection with equation (23)) that if we use the airgap D_0 of Fig. 9, and give the plunger an area of 22.16 square inches, with a density of 13000 in the airgap, the conditions of our problem will be fulfilled. A plunger 22.16 square inches in cross-sectional area will have a diameter of 5 5-16 inches, which checks with the assumed value.

The next step must be to the end of determining whether the winding space $F\ B\ C\ E$ is large enough to contain the magnetizing coil.

The data necessary to the determination of the total m. m. f. required is contained in Table I, the numbers in column (6) being the product of the corresponding numbers tabulated in columns (3) and (5). The sum of all the numbers in column (6) is 2738.7, therefore,

$$2738.7 \times 2.54 = 6956 \text{ gilberts.....(46)}$$

and is the total m. m. f. required in the complete magnetic circuit.

$$6956 \div 1.257 = 5533 \text{ ampere turns.....(47)}$$

must therefore be developed in the exciting winding.

Before we can determine the dimensions of such a coil we must first develop an expression for the size of the wire needed. In determining the resistance of a wire we have the fundamental formula that

$$R = \frac{K\,L}{\widehat{m}} \text{.....(48)}$$

where R is the resistance of the wire, $\widehat{m}$ its cross-section in circular mils, L its length in feet and K the resistance in ohms of a mil-foot of copper at the working temperature of the wire. Therefore, the cross-section of the wire in circular mils is

$$\widehat{m} = \frac{K\,L}{R} = \frac{K\times L'\times S}{12\times R} = \frac{K\times L'\times (S\,I)}{12\times E} \text{.....(49)}$$

where L' is the mean length of a turn in inches, S the number of turns in the coil, I the current in amperes needed and E the e. m. f. impressed upon the coil. Substituting therefore in (43) we get

$$\widehat{m} = \frac{11.29\times 7.86\times\pi\times 5533}{12\times 55} = 2340.... \text{.....(50)}$$

Since $K = 11.29$ at 43° C., $L' = 7.86'' \times \pi$ by approximation from Fig. 7, $S\,I = 5533$ as determined above and $E = 55$.

As a No. 18 B. W. G. wire has an area of 2401 $\widehat{m}$, it may suffice. It has a resistance of .004698 ohms per ft. at 43° C., as determined from a standard wiring table, and when insulated with a double cotton covering will wind approximately 280 turns per square inch of spool winding area.

In order to determine the safe current carrying capacity of this wire under the present conditions we must ascertain the radiating power of the outer surface of the iron incasing jacket. From Fig. 7 it will be seen that the

Top of the jacket has an outer surface of approximately
$8.5\times\pi\times 3.25 = 85.7$ sq. ins.
Cylindrical sides have a surface of $11.75\times\pi\times 5 = 184.0$ sq. ins.
Lower conical cap has an outer area of approximately
$8.5\times\pi\times 4.5 = 120.0$ sq. ins.
Making the total available external radiating surface of the jacket = 389.7 sq. ins.

Now it has been experimentally determined[8] that .012 watts will be radiated per square inch per degree rise in temperature from dull iron surfaces at rest, so that we are safe in assuming that the jacket will radiate

$$389.7\times .012 = 4.67 \text{ watts.....(51)}$$

per degree rise in the temperature of its outer surface above that of the air. The maximum current that the wire can carry, therefore, and keep the temperature of the magnet within the limits of 23° C. rise above the temperature of the air is

$$\frac{4.67\times 23}{55} = 1.98 \text{ amperes.....(52)}$$

With this current flowing, from (47), we must have

$$\frac{5533}{1.98} = 2820 \text{.....(53)}$$

turns of wire in the exciting coil, and since No. 18 B. W. G., D. C. C. wire winds 280 turns to the square inch of spool area, 2820 turns will require a winding section of

$$\frac{2820}{280} = 9.75 \text{ square inches.....(54)}$$

Now the available length of the winding space by our assumed dimensions in Fig. 7 is 5" from F to B, Fig. 9, less two brass spool ends each $\frac{1}{8}$" thick, two linings of insulation each 1-32" thick and 1-16" clearance space, or a net length of 4.625 inches. The depth of the winding will be, then, $9.75 \div 4.625 = 2.11$". The depth allowed in Fig. 7 is 2.5" less the thickness of the spool, $\frac{1}{8}$" the thickness of the spool insulation lining 1-32" and the clearance 1-16" between the spool and the inner pole, giving a net depth available of 2.28". The winding will therefore fill the spool to within $2.28 - 2.11 = .17$" of the inside surface of the jacket. The winding will therefore just comfortably fill the space allowed.

[8] Timmerman, Trans. *Amer. Inst. Elec. Engrs.*, Vol. 10, p. 342, 1893.

Again, the mean diameter of a turn of the winding will be

$$5\ ^{5}/_{16}'' + (^{1}/_{16} + ^{1}/_{8} + ^{1}/_{32})\ 2 + 2.11 = 7.86'',$$

so that the mean length of a turn will be $7.86 \times \pi = 24.7''$.

Therefore the total length of wire used is

$$\frac{24.7 \times 2820}{12} = 5800 \text{ feet} \quad \ldots\ldots(55)$$

of No. 18 B. W. G., D. C. C. wire, which at 43° C. will have a resistance of

$$5800 \times .004698 = 27.3 \text{ ohms} \quad \ldots\ldots(56)$$

and when the coil is connected in circuit until it has become heated up to its normal working temperature,

$$\frac{55}{27.3} = 2.01 \text{ amperes} \quad \ldots\ldots(57)$$

will flow in the winding, which is a value but 1.32 per cent. larger than the allowable current determined by equation (52).

Our calculations at the present point fit together very nicely, and the proportions of the magnet may be considered satisfactory but for the fact that the length of the working airgap, $D_0 = .162''$, is almost too small to admit of the magnet rendering any practical service. If, however, we take advantage of the suggestion contained in equation (37) we can materially improve the working range, and thereby reduce the initial pull. By bounding the working airgap with conical instead of flat faces, so that the slanting surface ($G\ N$) makes an angle of 60° with the horizontal ($N\ B$), we have,

That the area of the conical pole face equals $(5.31^2 \times \pi \div 4) \times \text{secant } 60° = 22.2 \times 2 = 44.4$ sq. ins. $\ldots\ldots(58)$

That the magnetic density in the airgap is $13000 \div 2 = 6500$ gausses $\ldots\ldots(59)$

That the perpendicular distance from pole face to pole face (L') is $D_0 \times 2 = .162 \times 2 = .324''$ $\ldots\ldots(60)$

And that the working range (D') of the plunger is $D_0 \times 4 = .162 \times 4 = .648''$ $\ldots\ldots(61)$

The working range will thereby be brought within practical limits, and the initial pull will be reduced to $350 \div .648 = 540$ pounds $\ldots\ldots(62)$

The design of the electromagnet has now progressed so far towards completion that we can to advantage check up the value of the leakage coefficient and make a calculation to determine whether or not the wire in the magnetizing coil will be heated to a dangerously high temperature.

The leakage coefficient can be calculated with the greatest degree of accuracy by carefully mapping out the probable leakage paths and calculating the permeance of these paths relatively to the permeance of the working airgap.

To present this matter in concise form I will refer to Fig. 9. A leakage of lines of force will take place between the cylindrical area $A\ B$ and the discoidal surface $B\ I$, along the mean path P_b between 1 and 2.

Now by definition, the *Absolute Permeance* (P) of any path in air is equal to the mean of the areas bounding the ends of the path divided by the mean length of the path between the bounding areas.

And further, the *Relative Permeance* (P') of any path in air is equal to the *absolute permeance* of the path *multiplied* by the *mean m. m. f. acting on the path* and divided by *the total m. m. f. acting* on the magnetic circuit.

Therefore the absolute permeance of the leakage path P_b will be equal to

$$P_b = \frac{.5\ (\text{Cylindrical area } A\ B + \text{Discoidal area } B\ I)}{\text{Length of the dotted line (1–2)}} \quad \ldots\ldots(63)$$

Now the magnetizing coil, through which the current producing the total m. m. f. flows, practically fills the space ($F\ B\ C\ E\ F$), and therefore the area ($F\ B\ C\ E\ F$) may be taken as proportional to the total m. m. f. impressed. This being the case, the area ($A\ B\ I\ M\ A$) may be taken to represent that part of the total m. m. f. that is effective in setting up magnetic leakage between the surfaces ($A\ B$) and ($B\ I$). And therefore the relative permeance of the leakage P_b will be equal to

$$P'_b = \frac{.5\ (\text{Cylindrical area } A\ B + \text{Discoidal area } B\ I)}{\text{Length of the dotted line (1–2)}} \times \frac{\text{Plane area } (A\ B\ I\ M\ A)}{\text{Plane area } (F\ B\ C\ E\ F)}$$

$$= \frac{.5\ [(N\ B)\ \pi\ (A\ B) + (N\ 2)\ \pi\ (B\ I)]}{(1\text{–}2)} \times \frac{(A\ B)\ (B\ I)}{(F\ B)\ (B\ C)}$$

$$= \frac{.5\ (5.313 \times \pi \times 1.25 + 6.56 \times \pi \times 1.25)}{1.25 \times \pi \times .25} \times \frac{1.25 \times 1.25}{5 \times 2.5} = 1.467 \ldots(64)$$

Correspondingly there will be a leakage between the discoidal surface ($I\ C$) and the cylindrical surface ($C\ D$); and the relative permeance of the path bounded by these surfaces will be

$$P'_c = \frac{.5\ [(N\ 3)\ \pi\ (I\ C) + (N\ C)\ \pi\ (C\ D)]}{(3\text{–}4)} \times \frac{(I\ C)\ (C\ D)}{(F\ B)\ (B\ C)}$$

$$= \frac{.5\ (9.06 \times \pi \times 1.25 + 10.3 \times \pi \times 1.25)}{1.25 \times \pi \times .25} \times \frac{1.25 \times 1.25}{5 \times 2.5} = 2.44 \ldots(65)$$

The leakage that takes place between the cylindrical surface ($A\ H$) and the cylindrical surface ($D\ E$) by the path P_d is relatively much more important, as the mean m. m. f. acting on it is much greater, being in fact proportional to the mean of the areas ($A\ B\ C\ D\ A$) and ($H\ B\ C\ E\ H$). For the relative permeance by the path (5-8) we get,

$$P'_d = \frac{.5\ [(N\ B)\ \pi\ (A\ H) + (N\ C)\ \pi\ (D\ E)]}{(5\text{–}8)} \times \frac{.5\ [(ABCDA) + (HBCEH)]}{(F\ B\ C\ E\ F)}$$

$$= \frac{.5\ (5.31 \times \pi \times 1.988 + 10.31 \times \pi \times 3.75)}{2.62} \times \frac{.5\ (3.25 + 8.72)}{5 \times 2.5} = 14.15. \ldots(66)$$

The only other leakage path of importance is that bounded by the cylindrical surface ($H\ G$) and the discoidal surface ($F\ E$). The path connecting them is along the line P_e and the m. m. f. acting on this path is proportional to the mean of the areas ($H\ B\ C\ E\ H$) and ($F\ B\ C\ E\ F$). Therefore the relative permeance by this path is,

$$P'_e = \frac{.5\ [(N\ B)\ \pi\ (H\ G) + (N\ I)\ \pi\ (F\ E)]}{(7\text{–}6)} \times \frac{.5\ [(HBCEH) + (FBCEF)]}{(FBCEF)}$$

$$= \frac{.5\ (5.31 \times \pi \times 1 + 7.81 \times \pi \times 2.5)}{1.875} \times \frac{.5\ (8.72 + 12.5)}{12.5} = 17.92. \ldots(67)$$

We have now determined the permeances of the several leakage paths, as owing to the ironclad design of the magnet there will be practically no leakage between points on the outside of the iron case, the distances in air between such points, relatively to the m. m. fs. acting being too great.

We must now determine the relative permeance of the path followed by the flux passing through the working airgap. Here, as in the previous calculations, we can entirely neglect the reluctance of the ferric part of the circuit and merely consider the effect of the two airgaps, the working airgap ($G\ N$), and the plunger airgap ($F\ J$), which are magnetically in series with one another.

The absolute permeance of the working airgap is equal to the total area of the conical bounding surface of one face $(5.313^2 \times \pi \times .25 \times 2)$ divided by the perpendicular distance across the working airgap, $L' = .322$, or to

$$\frac{5.313^2 \times \pi \times 2}{4 \times .322} = 138 \quad \ldots\ldots(68)$$

and the absolute permeance of the plunger airgap is equal to the cylindrical surface area of the gap at ($F\ J$) divided by the length of the gap, or to

$$\frac{5.344 \times \pi \times 2.75}{.031} = 1680 \quad \ldots\ldots(69)$$

And, therefore, since the two airgaps are magnetically in series, the absolute permeance of the path through them will be the reciprocal of the sum of the reluctances of the airgaps, or to

$$P_a = \frac{1}{\frac{1}{138} + \frac{1}{1680}} = 126 \quad \ldots\ldots(70)$$

which is also equal to the relative permeance (P'_a) of the path through these airgaps as "the mean m. m. f. acting on" this path is equal to "the total m. m. f. acting on the magnetic circuit."

We are now in a position to find the value of λ the factor of magnetic leakage, as it is equal to the quotient obtained by dividing the joint relative permeance of the useful and stray paths by the relative permeance of the useful path, or

$$\lambda = \frac{P'_a + P'_b + P'_c + P'_d + P'_e}{P'_a} = \frac{126 + 1.467 + 2.44 + 14.15 + 17.92}{126}$$

$$= 1.284 \quad \ldots\ldots(71)$$

This value checks with the assumed value of 1.30.

As regards the maximum temperature that will probably be attained by the wire of the exciting coil when the magnet is continuously in operation, we can make a sufficiently accurate estimate by ascertaining the temperature the outer layers of the coil will reach if connected continuously across 55-volt mains after being *removed*

from the enclosing iron case or jacket.[6] In doing this we may follow the method previously used in calculating the radiating power of the encasing jacket. Since the radiating surface of

The spool heads is $(5.31 + 2.33)\pi \times 2.33 \times 2$ = 112.0 sq. ins.
The outer surface is $(5.31 + 2.33 + 2.33)\pi \times 4.875$ = 152.3 sq. ins.
The inner surface is $(5.31 + .125)\pi \times 4.875$ = 83.2 sq. ins.
Making a total of 347.5 sq. ins.

the spool will radiate, by equation (51),

$$347.5 \times .012 = 4.17 \text{ watts}$$

per degree rise of the temperature of its outer surface above that of the air, and therefore the temperature reached by the outer surface under the conditions specified will be

$$\frac{55 \times 2.01}{4.17} = 26.4^\circ \text{ C} \ldots\ldots\ldots\ldots\ldots\ldots (72)$$

above that of the surrounding air. Owing to the fact that the iron jacket will conduct the heat away from the surface of the brass spool very rapidly, the temperature of the wire will be kept well within the safe heating limit.

This completes the calculation of the design, the remaining work being carried out on the drafting board. In proportioning the several parts of the frame (see Fig. 7) care has been taken to have the finished magnet conform as closely as is consistent with its practical usefulness to the letter of the assumptions upon which the calculations are based. Certain slight departures were, however, desirable, as, for instance, the modeling of the centre of the plunger, as shown by the heavy line, instead of as shown by the dotted line (K J). Had the dotted line been followed the density in all parts of the plunger would have been exactly 13000 gausses, but a sufficient bearing surface would have been lacking.

To the end of studying the relations existing between the initial pull, work and leakage coefficient of the magnet, just designed, somewhat more in detail, Mr. Mug has recently carried these calculations to the point of determining the conditions that obtain when different densities are assumed to be maintained in the inner core, the plunger and the working airgap. The results of his calculations are tabulated in Table II, and were obtained by the following line of treatment:

Assume that the magnetic density in the inner pole and plunger is 10000 gausses, and assume that the leakage coefficient in this case is 1.42. What will be the length D_0 of the working airgap, the initial pull and the actual value of the leakage coefficient, corresponding to the assumed density?

The maximum density in the circuit = 10000×1.42 = 14200
The medium density in the circuit = 10000×1.21 = 12100
The minimum density in the circuit = 10000×1.00 = 10000
The density in the coil cap = $\frac{10000}{13000} \times 8930$ = 6880
The density in the plunger gap = $\frac{10000}{13000} \times 5750$ = 4425
The density in the frame joint at E = 10000

The values of H and L corresponding to these densities, as explained in the previous calculations, are

B	H	L	B	H	L
14200	20.0	4.45″	6880	2.80	3.45″
12,100	11.6	3.37″	4425	4425	0.031″
10000	7.2	7.50″	10000	10000	0.001″

TABLE II.

Density in the Plunger in Gausses. A	M. M. F. Impressed on Iron. Gilberts. B	M. M. F. Impressed on Working Airgap, Gausses. C	Length of Working Airgap, D_0, Inches. D	Actual Working Range of Plunger, Inches. E	Initial Pull in Pounds. F	Work in Inch-Pounds. G	Leakage Coefficient. H
10000	861	6095	.240	.960	320	307	1.41
11000	1051	5905	.211	.844	387	327	1.37
12000	1269	5687	.186	744	460	342	1.33
13000	1598	5358	.162	.648	540	350	1.28
14000	2157	4799	.135	.540	626	338	1.24
18000	6956	0	0	0	1039	0	1.02

And therefore $\Sigma H L$ for the ferric portion of the circuit, or the m. m. f. impressed on all the circuit except the working airgap, is proportional to 339, or equal to $339 \times 2.54 = 861$ gilberts. But, since the magnetizing current is constant the total m. m. f. impressed by the magnetizing coil is constant and proportional to 2738.7 (see Table I), or equal to $2739 \times 2.54 = 6956$ gilberts, therefore the length of the working airgap will be,

$$\frac{2739 - 339}{10000} = 0.24'' = D_0 \text{ for the density of } 10000;$$

as all the surplus m. m. f., or m. m. f. not expended on the ferric circuit, must be used up in the working airgap.

Now by (30) the pull per sq. in. of pole face area, or the initial pull when $D_0 = .24''$, will be

$$\frac{\frac{9}{10000 \times 6.45}}{11,183,400} = 57.67.$$

And the work performed by the magnet, starting from the position in which the airgap $D_0 = .24''$, will be

$$57.67 \times 22.2 \times .24 = 306.7 \text{ inch-pounds.}$$

The values of D_0 and of the work performed, as just calculated are correct if the assumed value of $\lambda = 14.2$ is correct. To check the exactness of this assumption we can follow the method already employed on page ( ). If we inspect Fig. 9 in the light of the new condition we find that the values of P'_b, P'_c, P'_d and P'_e, as determined in equations (64), (65), (66) and (67), remain unchanged, and that the absolute permeance of the plunger airgap is the same. Therefore the absolute permeance of the working airgap is the only

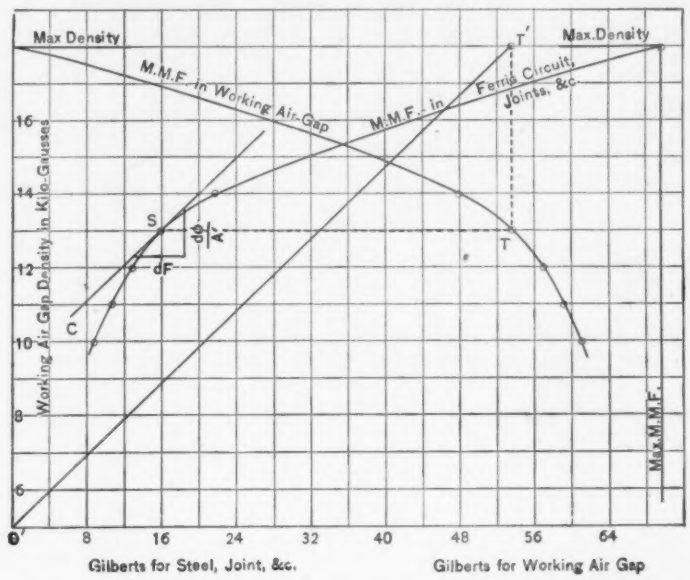


FIG. 10.—THE AIRGAP CHARACTERISTIC OF A TRACTIVE ELECTROMAGNET.

quantity that is modified in view of the new density, and its value is changed by equation (68) from 138 to

$$\frac{\frac{2}{5.313 \times \pi \times 2}}{4 \times (2 \times .24)} = 92.36.$$

We can now apply equation (70) and solve for the new value of

$$P'_a = \frac{1}{\frac{1}{92.36} + \frac{1}{1680}} = 86.9.$$

Then by equation (71) the value of the leakage coefficient in the present case is

$$\lambda = \frac{35.97 + 86.9}{86.9} = 1.413,$$

which checks sufficiently closely with the assumed value of 1.42.

The other values tabulated in Table II, corresponding to the remaining densities, were determined by the same process, and illustrate very clearly what transpires as the plunger of such a magnet moves up and down.

The curves shown in Fig. 10 are analogous to those shown in Fig. 2, and are plotted from the data contained in columns A, B and C of Table II. It is graphically demonstrated that a line (O' T') drawn from the origin to the point (T) on the working airgap curve corresponding to a density of 13000, is parallel to a tangent (C S) drawn to the ferric circuit curve at the corresponding density point (S).

In Fig. 11 a still greater evidence is given of the prominence of the plunger position for maximum work. In this figure the leakage co-

[6] For more exact determination see "Heating of Magnet Coils," H. S. Carhart, *Electrical World*, Vol. 29, p. 11, 1897.

efficient, initial pull and work have been plotted against the length of the working airgap, and it is seen that the crest of the work curve, that is plotted between the values of columns G and E of Table II, comes to a well defined crest above the airgap length of .648 of an inch.

It must not be forgotten in interpreting these curves that in all this consideration of tractive magnets, the product of the initial pull and the range of motion is taken as the work done by the magnet. The total work which the magnet is capable of performing is far in excess of that determined in accordance with the definition used,

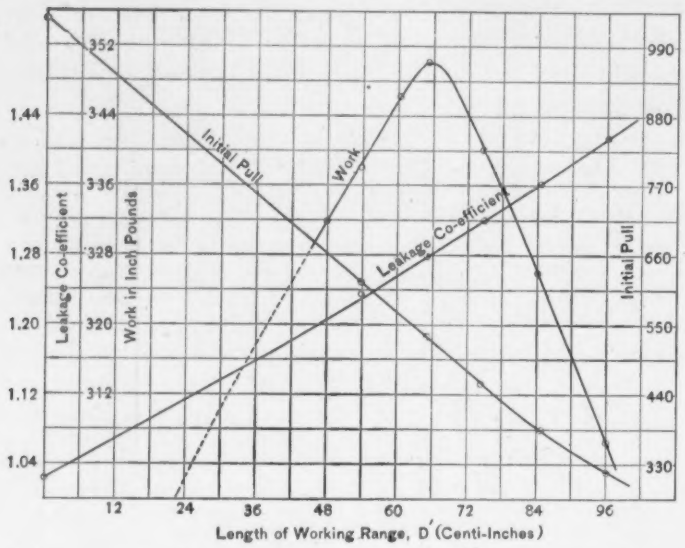


FIG. II.—THE WORK CHARACTERISTIC OF A TRACTIVE ELECTROMAGNET.

though the excess is usually taken up by dashpots, springs, weights or other devices for controlling the rate of movement of the plunger, and is not available for other uses. The total amount of work done by the magnet, from the minimum attraction with the plunger in its extreme position up to the maximum pull exerted with the least airgap and maximum flux, can be gotten by integrating the area inclosed between the *"work curve"* and the base line in Fig. 11.

It is seen that within the range of our calculations the initial pull has varied from 320 pounds to 1039 pounds, and that when the

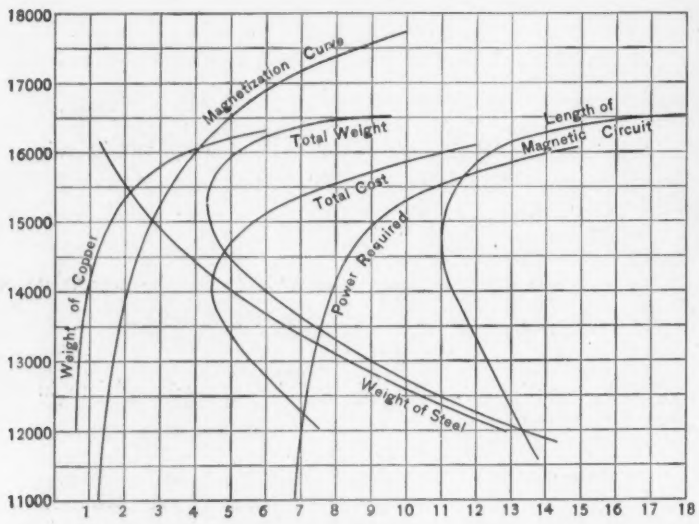


FIG. 12.—CURVES FOR THE DETERMINATION OF THE MOST EFFICIENT TRACTIVE ELECTROMAGNET.

plunger is on its seat it can be used very effectively as a portative magnet; it would, however, be difficult to so arrange the conditions that the magnet would give a greater useful work performance than that represented by the product of a pull of 540 pounds and a working range of .648 of an inch.

In the design of a tractive electromagnet the fact of making correct preliminary assumptions is of prime importance. I have already called attention to this matter,[1] which the curves of Fig. 12 bring out very clearly. The curves are based upon a series of designs of electromagnets to perform 100 inch-pounds of work with different initial airgap densities, each magnet being designed for the performance of maximum work at the density assumed. The designs are all of the same type, and work at the same temperature; and are as nearly comparable as a set of designs of such widely different dimensions can be made to be. This example may be taken as a guide in designing magnets for other capacities, as the same modifications exist in all cases; they only vary in degree.

[1] W. E. Goldsborough, *Elec. Wld.*, Vol. 29, p. 196, 1897.

The Palaces of Optics and of Light at the Paris Exposition.

The manner in which electric light and power are depended upon as attractions at the Paris Exposition has been referred to in previous articles in these columns, and is certainly remarkable enough to constitute one of the features of the great show as well as to leave one of the deepest impressions derived by the visitor. This use of electricity is not confined to the regular work of the administration, nor is it to be found exemplified simply in the exhibits proper. As a matter of fact, the exhibits "improper," or side shows, are profuse in their electrical appeal to the eye, and much of their mechanism is operated by motor. In some instances, however, these side shows deserve a much better name than one which ranks them with the lewd performances in the Rue de Paris or with the salacious scenes on the Trocadero slopes. Chief among the spectacles with an educational purpose and intended to teach "popular science" in an easy, useful way, are the two Palaces of Optics and of Light, which stand on the Champ de Mars, one on each side of the Eiffel Tower. The former building, by far the larger of the two, on the right as you look toward

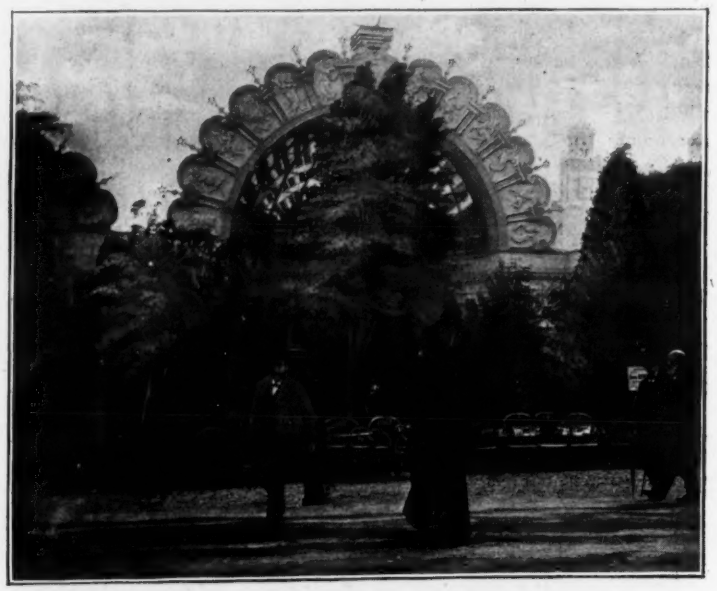


FIG. I.—PRINCIPAL FAÇADE, PALACE OF OPTICS.

the Chateau d'Eau, would be noteworthy if only for the fact that it contains a huge siderostat, based on the method adopted by Foucault many years ago. In this siderostat, the telescope is fixed in a horizontal position and pointed at a synchronizing mirror in which the object to be observed is reflected. The siderostat system weighs, all told, about 45 tons. The telescope tube is 200 ft. in length and 4½ ft. in diameter, being built up of 24 steel sections each 8 ft. long, carried on heavy piers which go down to the earth. The siderostat is placed to the north, and at the southern, eye-piece end is a large theatre where objects reflected can be projected upon a huge screen about 30 ft. square, while in the day time or in dull weather these images are replaced by lantern slides made from celestial photographs. The mirror glass is 6½ ft. in diameter, 10½ ins. thick, and weighs over 3½ tons, being also ground and polished by machinery. The lenses of the telescope are 50 ins. in diameter, weigh about 1600 lbs. each, and cost each, it is said, about $15,000. The whole work has been carried out under the direction and plans of M. Gautier, of the French Bureau des Longitudes. It is stated that the magnification is over 8000 diameters, and that the moon is brought within a distance of about 45 miles.

The palace is divided up into a large number of sections or rooms around the siderostat in each of which some phenomena connected with optics and light are demonstrated, and electricity is employed and illustrated most profusely, the service lighting alone requiring some 3000 amperes, while there are 15 miles of distributing circuit over which are scattered 14,000 incandescent lamps of 16 and 32 candle-

FIG. 2.—LUMINOUS PALACE OF GLASS.

power, and a large number of arcs. There is also a Barbier projector for an arc of 150,000 candle-power, at the entrance to the palace. The various rooms are named after such celebrities as Franklin, Becquerel, Mascart, d'Arsonval, Helmholtz, etc., and they occupy not less than 12,000 square metres, all told. In the Röntgen room, particular attention is given to the curious effects of the ray and to the

FIG. 3.—ILLUMINATED BALUSTRADE, LUMINOUS PALACE.

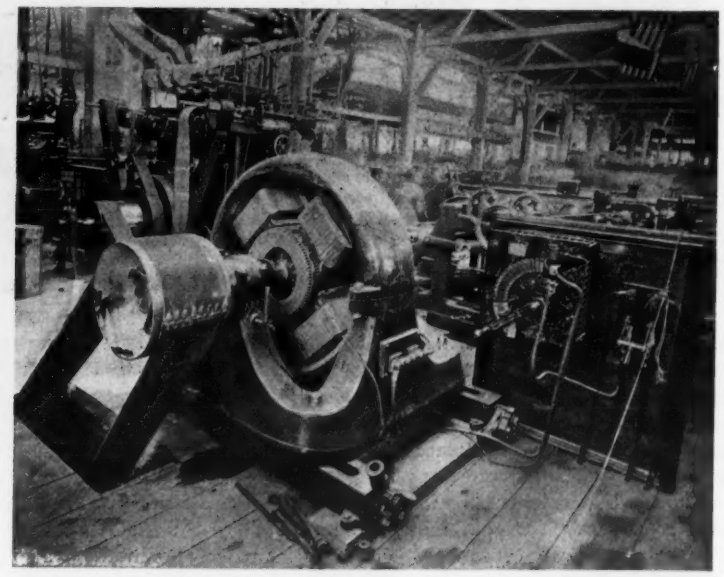
examination of living bodies behind a radiograph screen of platinocyanide of barium 6½ ft. high by 3 ft. wide. In the Crookes room there is a striking display of "cold light," associated more especially with the tubes of Crookes, Tesla and d'Arsonval. Their three names are worked out in such tubes on large panels by M. Gaston Seguy, the electrical engineer of the palace, who has grouped here no fewer than 900 vacuum tubes of different types, plain or with phosphorescent and fluorescent substances in them. It is doubtful whether a collection of anything approximating such magnitude in this line has ever been made before.

The façade of the Palace of Optics is shown herewith. It is due to the architect, M. Prosper Bobin, and has as its chief feature the cupola or dome, the decoration of which is the twelve signs of the zodiac. The crest of the scrolled front is decorated with clusters of incandescent lamps.

Across on the other side of the esplanade of the Champ de Mars stands the Palais Lumineux, or Luminous Palace, a curious and interesting structure whose object appears to be the illustration of the value and beauty of glass, combined with the electric light, for structural and decorative purposes. It is situated at the edge of a large pool into which its cascade plays and which at night mirrors its reflection very beautifully. So far as can be judged, it is built wholly of glass—stairways, balustrades, walls, ceiling, dome, rocks, portieres, etc., and wherever possible the material has been cast or blown hollow so that incandescent lamps can be introduced. Thus the approach seen in one of the views has steps of light, with lamps concealed in the glass slab and handrail, and others in the huge glass seashells which constitute the supporting posts. Access is had to the lights by removing sections or covers of the glass. Under the palace is a grotto in which the colossal stalactites and stalagmites are made of glass and illuminated electrically. The palace itself, although merely a bazaar supplemented by a neat display of glass blowing, offers some very pretty effects in the use of glass shades and fixtures for the incandescent lamps. By day, the color effects are pink and green, but at night some remarkably fine amber tones are brought out on the dome. It is stated that not less than 12,000 lamps are employed around the palace, but that figure may perhaps be accepted with reserve, especially as there are no facilities for counting so many concealed illuminants. The idea and execution of the palace are attributable to Messrs. Ponsin and Latapy, who are to be congratulated on their artistic achievement, which excites not less attention among visitors than did the equally ambitious but more prosaic exhibit of the Libby Glass Works at Chicago in 1893. There are many lessons to be learned and followed out from the novel effects thus created with glass, not only for spectacular purposes, but in the ordinary details of public and domestic lighting.

The Exhibit of the Triumph Electric Company.

The Triumph Electric Company, of Cincinnati, Ohio, has at the Paris Exposition a joint exhibit with the Fay & Egan Company, of the same city. Part of this exhibit is located in the American section



60-HP TRIUMPH MOTOR AND SWITCHBOARD.

of Electricity Building, Champ de Mars and the other and larger part in the American Machinery Building, at Vincennes.

The Fay & Egan Company shows a large variety of wood-working machine tools, and Triumph motors are used exclusively to operate these machines.

At the Champ de Mars the machines exhibited are driven by a

22-hp, 220-volt motor, standing on the floor, and belted to a line shaft beneath the floor, from which all the machines are driven. The motor runs at 1050 r. p. m., and is of the Triumph Company's regular, multipolar, medium-speed type.

The spaces of all the American exhibitors on the ground floor of Electricity Building are cramped to the utmost, and that of the Triumph-Fay & Egan Company exhibit is no exception. The office desk is placed on a platform about four feet above the floor, which is reached by steps and elevated, with iron guard-railed passways from either side of the block. The motor is placed a little to one side of this elevated structure, while the line shaft is directly below it.

The exhibit in the American Machinery Building at Vincennes is considerably larger than that at the Champ de Mars. The collection of wood-working machines shown here is most complete, and four Triumph motors are employed for driving. Of these the three smaller ones drive single machines, while the larger one, shown in our illustration, is belted to a sub-floor line shaft, from which quite a number of machines are driven.

A 5-hp, 800-rev. motor, placed on the floor, is used to operate an automatic glue-jointing machine. This latter machine requires four power transmissions, or four different motions, and a novel disposition of the motor has been adopted to make room for this number of pulleys on the shaft. The motor has only one bearing, the one at the commutator end, to which the brush rocker is fastened. The armature shaft runs in the bearings of two inverted hangers, fastened to the floor, one at either end of the motor. The hanger at the rear end of the armature is placed at quite a distance from the machine, and the four pulleys are placed on the shaft inside of this hanger.

A 4-hp, 500-rev. motor, operating a wood-turning lathe, has also only one bearing, while an inverted hanger supports the armature at the pulley end. Two differently sized pulleys, for obtaining different speeds of the lathe, are placed inside this hanger. This motor is also placed on the floor.

Another motor of 11 horse-power, placed on an overhead structure, drives a hollow chisel car-mortising machine. This motor has only one bearing proper, and the armature shaft runs in the bearings of two inverted hangers, both placed at the pulley end of the armature. Five pulleys, each provided with a belt, are keyed to the armature shaft between these two hangers.

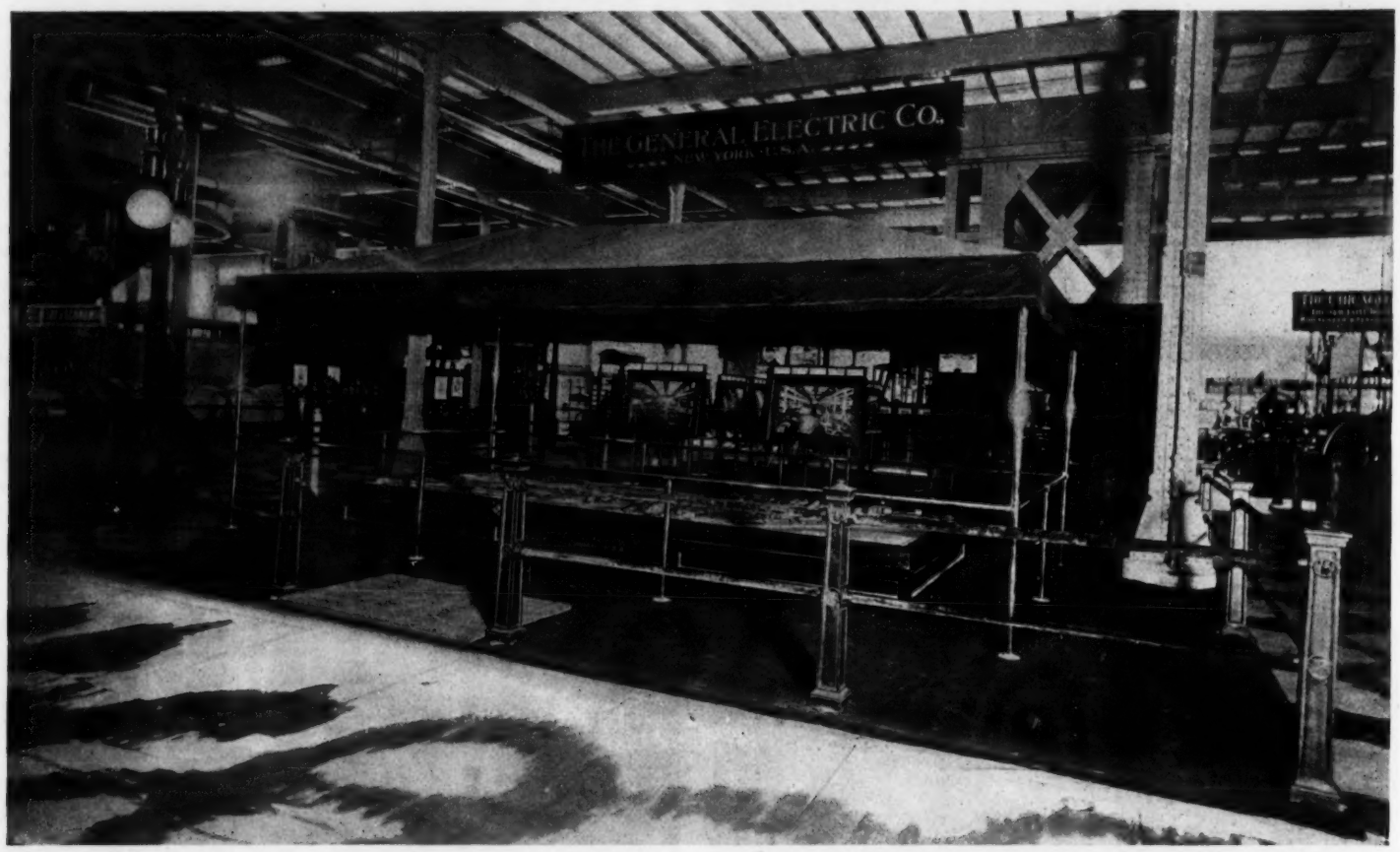
The largest of the four motors has a capacity of 60 horse-power and runs at a speed of 800 r. p. m. It is placed on the floor, and belted to a line shaft, 60 ft. in length, beneath the floor. All the motors are wound for 220 volts, the distribution pressure of the plant.

The starting boxes, fuses and switches are fastened to switchboards placed near the machine, except in the case of the motor on the superstructure. All the starters are of the Cutler-Hammer Manufacturing Company's make.

The total capacity of the Triumph Company's exhibit is over 100 horse-power, and it contains motors covering a considerable range of power. The arrangement of the joint exhibit permits the firm to show its machines in operation under load, and thus give a practical demonstration of their working qualities.

The Exhibit of the General Electric Company.

The fact that there are several companies operating in Europe under General Electric patents, rights and licenses, has militated against any comprehensive exhibit by the General Electric Company of its wide range of manufactures, while the division of the apparatus in each group, into separate nationalities, has again prevented these various branches and associated organizations from getting together, in the physical sense, and making a joint exhibit of an imposing character. Under these circumstances, the plan adopted by the company is probably the best which could have been selected, and consists essentially in setting forth its resources.



VIEW OF THE EXHIBIT OF THE GENERAL ELECTRIC COMPANY.

The company has a spacious stand on the ground floor of Electricity Building, right along the main aisle and to the right, when passing from the foreign to the French section. The most prominent part of its display is a model of its three factories, made to a scale of 20 ft. to one inch. The model is placed on a draped platform, 12 ins. high., covered by a canopy, and protected by a guard railing of nickeled brass tubing. The model, which was made by Edwin E. Howell, of Washington, D. C., shows the complete works of the company, but each of the three factories is fenced in separately. The ground is constructed in sheet zinc, cut away where the buildings are located. The buildings are of sheet copper with mica windows. The model is lighted from below with three rows of 18 incandescent lamps each, and from above by three rows of eight lamps each. Each of these rows of lamps, above as well as below, is controlled by a separate switch. The models are beautifully colored, and an infinite variety of details, making for verisimilitude, are brought out.

Each afternoon, when the light of day is fading, which happens rather early in this part of Electricity Building, the model is lit up from below, and the passing crowds have then an opportunity to admire the beautiful spectacle of a large American industrial establishment at night, depicted here in a very attractive manner.

It may be mentioned that the area represented by the models amounts to 174 acres, and that the buildings shown have a floor space of two million square feet. The models give a fair idea of the vastness of this enterprise. Besides this group model, the General Electric Company shows interior photographic views of its works, and views of some of the larger of its installations. The photos are of extraordinary size—36 ins. x 24 ins.—the largest plate made in America. The following are the views from the works of the company: One view of the big machine shop in Schenectady, the largest in America, being 650 ft. long by 156 ft. wide, and having a total floor space of 143,000 sq. ft.; one view of the big foundry in which 750,000 lbs. of iron castings are produced daily; an interior view of the incandescent lamp works at Harrison, N. J., which have a daily capacity of 55,000 lamps, and one interior view of the meter room of the Lynn works, at which 90,000 meters are produced annually.

The 16 photographs of installations cover practically all the famous long-distance transmissions, and a number of the large metropolitan stations erected by the General Electric Company. These plants are all familiar to the readers of the ELECTRICAL WORLD AND ENGINEER, and it will suffice to simply mention a few of them here. As examples of large metropolitan central stations are shown the Duane Street station of the New York Edison Company and the Market Street station of the Chicago Edison Company. As examples of long-distance transmission plants; a sub-station of the Sacramento Power Transmission and the new Buffalo General Electric Company's station, which is fed by current from Niagara Falls. There is also a view of the Mechanicsville power house, from which the Scenectady works derive their motive power, and a photograph of the big B. & O. electric locomotive.

Although the General Electric Company has not a special exhibit of its manufactures at the Fair, there are to be found in the various parts of the Exposition a large number of motors and other apparatus of G. E. make. In the American Machinery Building, at Vincennes, there are alone over a dozen General Electric motors, of which one, that of the Indo-Egyptian Compress Company, has a capacity of 50 horse-power. The electric locomotive of the Paris-Orleans Railroad, exhibited at Vincennes, and which will haul the trains of the Orleans road through Paris, to and from the new depot on the bank of the Seine, is also a Schenectady creation. In the Navigation Building, in the United States section, there is a good display of General Electric marine sets.

The space is handsomely lighted and draped, as well as luxuriously furnished with easy chairs, tables, desks, etc., and is within a few yards of the exhibit made by the French Thomson-Houston Company and the Postel-Vinay Company, which build and handle in France apparatus of the distinctive Thomson-Houston and General Electric types.

Mr. J. J. Oolgaardt, the company's Exposition representative, is at the space constantly, receiving callers. Mr. E. W. Rice, second vice-president and chief of the engineering department, has also been in Paris for some time; while Mr. W. J. Clark, European representative in London of the company, comes over on an occasional visit from London.

PARIS EXPOSITION NOTES.

AMERICAN DAYS.—July 3 and 4 were what might be called American days at the Exposition and in Paris. On the former date was inaugurated the statue of Washington, and on the latter that of Lafayette. General Horace Porter, ambassador of the United States, presided at the festivities. Star-spangled badges were everywhere in evidence at the Exposition, and the Stars and Stripes were floating from the crest of the "Tour Eiffel." The attendance at the Exposition was 223,000 on the third, and 227,000 on the fourth of July.

THE PALACE OF ILLUSIONS, of which was given a short description last week, was this week the scene of a fête, given to the general commission. The great hall has been constructed to receive 20,000 persons, and 18,000 invitations had been given out, but only 5000 to 6000 of those invited were present. M. Picard, general commissioner of the Exposition, and the secretary of commerce, received those officially invited, at the entrance to the palais. The fête lasted from 3 to 6 o'clock.

MISHAPS to the larger machines in Electricity Building seem to be rather frequent. Some time ago, one of the alternating generators in the Bourdonnais section had its externally-disposed armature displaced sideways, to remove some of the field poles, which had been damaged, and at present three other machines in the same section are covered up with the usual green blankets. Two of the latter sets have engines of the same make, and the pistons have been withdrawn and returned to the factory, while the third case is that of an alternating generator, from which the collecting rings have been removed. In the Suffren section there is also one alternator which is out of order. All the tape has been removed from the armature coils, where they protrude from the core, and the upper half of the exciter frame has also been taken off.

VINCENNES.—On July 7 the American section in the Transportation Building at Vincennes was inaugurated. The American exhibits consist mainly of railway appliances, such as air-brakes, trolley-line material, rail bonds, signals, etc. There are, however, also a number of locomotives, cars and trucks exhibited.

ENGLAND LAST.—The last of the large generating sets to be thrown into operaton is a direct-current, direct-connected set in the English section. At present the commutator of the machine is turned off, and the set will be in operation by July 10. Visitors coming after that date should, therefore, miss nothing in Electricity Building, but they might be disappointed if they came earlier.

Visit of the American Institute of Electrical Engineers to London.

We learn from Mr. W. G. McMillan, the secretary of the British Institution of Electrical Engineers, that the members of the American Institute will be offered a trip up the Thames in electric launches on Sunday, Aug. 12, the visitors and their hosts leaving by a morning train for a starting point at a convenient part of the river, and returning the same way, after lunch at a waterside hotel. On the evening of Monday, Aug. 13, they will be entertained by the president (Prof. Perry), and members of the Institution at a dinner in London. On the Monday and Tuesday special visits will be arranged to works and places of interest in the neighborhood of London; particulars of these visits will be found awaiting the American guests on their arrival in England. Members of the American Institute who will be in London at the time of the visit are requested to place themselves in communication with the secretary of the Institution of Electrical Engineers, 28 Victoria Street, London, S. W., to which address they are also invited, if they care to do so, to have their mail forwarded.

The following is announced as the title of the subject selected for discussion at the joint meeting in Paris, at the Exposition, on Aug. 16: "The relative advantages of alternate and continuous currents for a general supply of electricity, especially with regard to interference with other interests."

CURRENT NEWS AND NOTES.

ELECTRICIANS IN THE NAVY.—By an executive order the President has fixed the pay of electricians in the navy at $60 per month for the chiefs, $50 for the first class electricians, $40 for the second class, and $30 for the third class.

A NERVE TEST.—The local police recently unearthed a novel organization of juvenile thieves in the city of Allegheny, Pa. It appears that the most requisite characteristic of the youthful members was a demonstration of an unusual amount of nerve, in order to satisfy themselves that the would-be member had been amply endowed in this respect it was necessary to stand an electric test. If the proposed member could stand the application of this current—the voltage was not mentioned—then the member could be enrolled.

CABLE TO BELLE ISLE ROCK.—The Canadian Government has announced its intention to lay a cable to Belle Isle Rock, in the Straits of Belle Isle, with the view of speedy notification in case of shipwreck and a possible prevention of wrecks. The superintendent of the Anglo-American Cable Company in that colony says that the Canadian Government cannot land a cable at Belle Isle without the consent of his company, the latter having a fifty-year monopoly of all cable rights within the colonial jurisdiction, said monopoly not ex-

piring until 1904. Belle Isle is included in the Newfoundland jurisdiction.

CHAMBLY POWER IN MONTREAL.—The recently-ratified agreement between the Montreal Electric Street Railway Company and the Chambly Power Company requires the delivery by the latter company of 5,000 horse-power continuously for a period of 23 years, with the privilege of renewal for a further term of five years, at $25 per horse-power per annum. Should the Chambly Company at any time sell power at a lower rate to any other railway in Montreal, the Montreal Street Railway will have the benefit of the reduction.

SNAKES IN A SWITCHBOARD.—The connection between snakes and Jersey lightning has always been well understood, but it is only now that an effort is reported on the part of the snakes to serve as mechanism in a switchboard. The fire-alarm system at Kearny, N. J., being out of order, an investigation was made. The board is in a basement, and on opening up a corner of it, two live and two dead snakes were found in it. They had caused all the trouble, the dead ones clogging the striker apparatus. They are supposed to have crawled in through a broken wndow.

ELECTRICAL PAGEANT.—Electricity played an important part in the Carnival, in Milwaukee, this year, and excelled the display of last year. The arching of one mile of the main business street at every trolley pole by incandescent lamps, the suspended electric belts and the outlining of several large buildings was a grand sight; but the main feature was the electrical pageant. It consisted of twenty floats raised and placed on flat electric cars. The floats were lighted by 6,000 incandescent lamps of different colors. The contract price for the making of the floats was $5,700 and the wiring and power and cars cost $1,800.

MESSENGER GIRLS IN LONDON.—The messenger girl has been tried in London and found wanting, or, rather, not wanted. There fell upon the metropolis a few weeks ago a dearth of boys so grievous that the district-messenger concerns had to employ girls. The papers devoted to women's rights were overjoyed at this new avenue of employment opened to the sex. The girl messengers certainly looked trim and worked quickly. But last week, finding it feasible to get the necessary boys, and for other reasons, the messenger concern discharged all its female protégées, and boys now reign in their stead. Thus ends an attempt that, if it had been successful, might have added greatly to the picturesqueness of London's streets.

AUTOMOBILE EXHIBITION.—The board of governors of the Automobile Club of America have issued notice of the exhibition of automobiles and accessories, which will be held at Madison Square Garden, from Nov. 3 to 10, 1900, under the auspices of the Automobile Club of America. The club committee on this exhibition announces that all the floor space of the Garden has been rented by intending exhibitors, and it is proposed to utilize some additional space by flooring over the boxes, for the exhibition of accessories. One of the features of the exhibition will be a circular track, on which automobiles of all kinds will be shown in motion, and it is proposed to utilize this track for the purpose of contests of various kinds, under the direction of the technical committee of the club, in the several classes of automobiles exhibited. The following gentlemen compose the exhibition committee: A. R. Shattuck, chairman, 11 Broadway; General George Moore Smith and E. E. Schwarzkopf. Communications or inquiries should be addressed to the chairman of the committee.

MEDICAL MAGNETIZERS.—It is stated that regular medical practitioners in France are much disturbed by the tendency of the courts to recognize magnetizers and persons who practice massage as legally-qualified doctors of medicine. This recognition is refused in some departments, but in many others these persons are permitted to treat fractures and dislocations and other surgical cases. "Magnetizers are getting more and more numerous," says a correspondent of the *Lancet*, "and have founded a school of magnetizer-masseurs which is a regular breeding ground for quacks, and which solemnly issues diplomas, by the aid of which the recipients make a good thing out of public credulity. They hold regular consultations, put a stop to treatment already recommended, and, not content with using magnetic passes, prescribe magnetized water which has been magnetized by themselves." The Court of Cassation is expected soon to render a decision defining the rights and privileges of these practitioners under the existing French law, which is believed, however, to be more favorable to them than is desirable.

MIRROR INDICATOR.—A patent has been issued in this country to Anton Pollak, of Buda-Pesth, on a mirror indicator for amplifying the movements of bodies, and is especially useful where such movements are so minute as to be imperceptible or incapable of determination by ordinary means. He provides an improved means for mounting the mirror, whereby it may oscillate with the utmost freedom and exactness around a pivotal edge, to which it is securely held. To this end he mounts the mirror upon a pivotal knife-edge and arranges it in connection with a magnetic field, by which it is held magnetically in contact with such pivotal edge. He also provides a pivotal edge or point through which the movements of the moving body are communicated to the mirror and utilizes the magnetic field for retaining the mirror in contact also with this moving point. The device is especially applicable for recording extremely rapid movements—as, for instance, those of a rapidly-vibrating body, such as a telephone diaphragm—and hence is of importance in those systems of facsimile telegraphy, or rapid telegraphy in which rapidly-oscillating parts are employed for varying a ray of light.

UNITED STATES PATENT OFFICE REPORT.—The report of Commissioner of Patents Duell for the fiscal year ended June 30 last shows a total of 26,540 patents granted, including reissues and designs. There were 1660 trade-marks, 682 labels and 93 prints registered. Patents that expired numbered 19,988. Allowed applications forfeited for non-payment of the final fees were 4052. Of the total of 39815 applications received, 2263 were for designs, 90 for reissues, 1739 for caveats, 2103 for trade-marks, 872 for labels and 127 for prints. The total receipts of the Patent Office were $1,358,228; total expenditures, $1,247,828; surplus turned into the Treasury, $110,402. On July 1, 30 out of the 36 examiners had their new work within one month from the date of filing, and three of the remaining six overran that time by only one day. The amended work in nearly all the divisions was being acted upon within fifteen days after filing. Applications awaiting action by the Patent Office numbered 3564, which is between 500 and 600 more than on July 1, 1899. The applications for patents, etc., received during the fiscal year just closed were 5000 more than during the preceding year.

PURIFICATION OF WATER.—To Mr. William M. Jewell, of Chicago, a patent has been issued on a method of electrical purification of water by coagulating and removing the impurities contained in them without the addition to the waters of deleterious soluble reagents, the use of the latter being objectionable for the reason that an excess of them may easily be added to the waters without physical detection, thereby in most cases rendering them unfit for potable purposes. He electrolyzes a solution of a suitable salt in which is immersed an anode composed of a substance adapted to be chemically acted upon by one or more of the constituents of the solution separated by the electrolytic decomposition to ultimately form a substantially-insoluble coagulant, introducing the freshly-formed coagulant into the water to be purified, and then filtering the water in the presence of such coagulant. The electrolyte is placed in a chamber separate from the conduit or chamber containing the water to be treated, but communicating therewith, the reaction between the products of the electrolytic action taking place in the chamber where they are produced, so that only the insoluble coagulant is introduced into the water to be purified, thus avoiding contamination. For example, the result may be obtained, Mr. Jewell states, by forming hydrate of iron by electrolyzing a solution of sodium chloride or its equivalent in the presence of an iron anode, the immediate products of the electrolysis being permitted to react upon each other, and afterward filtering the water to be purified in the presence of the hydrate of iron.

FRICTION IN METERS.—Mr. Caryl D. Haskins has received a patent and assigned it to the General Electric Company for an invention which has for its object to provide a simple and efficient method of adjusting the compensation for friction in electric meters without affecting the calibration of the meter. As is well known, this compensation is now usually accomplished by providing an auxiliary shunt field acting in the same direction as the series field. This is of high

resistance and very small effect, being designed to just balance the friction, so that the armature, when no current is being used, without actually turning is upon the very point of doing so. A number of ways of adjusting the effect of this coil have been proposed. In general it is found best to connect the coil in series with the armature, because by this the advantage of the high resistance of the armature circuit is obtained, so that the number of turns of the minute wire required in these fields may be considerably reduced. It is manifest, however, that this connection makes the resistance of the shunt coil a part of the total resistance of the armature circuit and that therefore any scheme of adjustment which contemplates varying its effect by changing the resistance or number of turns in the customary way for altering its magneto-motive force must be defective, because it changes the calibration of the meter. It is to afford a simple and convenient means of obviating this defect that Mr. Haskins devised the present invention, which consists of means for varying the magneto-motive force of the shunt starting coil with reference to the armature independent of any change in its absolute magneto-motive force. The most convenient way he has as yet devised for doing this is by mounting the starting coil (or a desired portion thereof) upon a pivot and adjusting its angular relation to the armature so that its inductive effect can be changed from zero to maximum, according to the direction of the plane of the coil.

ELECTRIC WATERPROOFING OF FABRICS.—For some time past, Mr. J. T. Van Gestel has been at work on the electrical waterproofing of fabrics, and two patents on the process and the apparatus have now been issued to him. Attempts to make fabrics waterproof and to set the dye therein by the use of the electric current have been made; but they have, it is said, only partially succeeded or failed entirely. In one of these attempts the wet fabric was passed between an oxidizable anode and a cathode with the expectation that the anode would be oxidized and the oxide carried into the fabric. This attempt was ineffectual. In the present invention to effect waterproofing the fabric is saturated in a bath of soluble metallic salts and then subjected to the action of the electric current, which causes an oxide of the metal to be formed in the interstices of the fabric. In fixing a dye the metallic salts are mingled with the dye in the goods under the influence of the electric current, thereby acting as a mordant in fixing the dye. It is found better to pass an electric current through the bath of metallic salts while the fabric to be treated is immersed therein. By this means the salts are carried into the interstices of the fabric and more evenly distributed through it. Mr. Van Gestel has devised apparatus which enables him to treat both sides of the fabric alike as it passes through. Just what the action is that takes place does not seem clear, but the fact is that the electric current, acting upon the metallic couple or the plates on the opposite sides of the wet fabric, causes oxidation to take place and produces a peculiar waterproofed or water-repellant effect upon the fabric. A metallic oxide of some kind is produced through the nascent oxygen, due to the electrolytic action of the current on the water in the goods, which is probably combined with the fibres both mechanically and chemically.

SLOTTED ARMATURE MACHINES.—Following up previous work in that direction, Mr. W. M. Mordey, the well-known English electrical engineer, has taken out a United States patent relative to slotted armature dynamo electric machines. His two earlier patents here dating back to 1897 described the combination of a suitable field magnet and a slotted or toothed ring armature and of a suitable field magnet and a slotted or toothed drum armature, the armature winding in each case being so arranged that opposing electromotive forces are produced in two connected portions of each element of the winding at the moment of commutation, but that during the greater portion of the revolution of the armature, mutually-aiding electromotive forces are produced in the respective portions of the elements of the winding. In other words, the arrangement of the winding is such that at the moment of commutation both the forward part of the element and the rearward part of the element have electromotive forces generated in them; but these electromotive forces are in opposite directions. By the balance or approximate balance of opposing electromotive forces at the time of commutation he is enabled to collect from portions of the armature situated in an active field instead of, as usual, from portions approximately in inactive or neutral positions, whereby while obviating sparking, certain advantages are obtained. Thus the effect of the armature winding in producing a demagnetizing action is greatly reduced. According to the present invention he carries this advantage further and causes the armature reaction to assist the magnetic system of the dynamo by supplying magnetizing force in an assisting direction. Mr. Mordey attains this object by so dividing and arranging or splaying the portions of each element of the winding on a core of "slotted" generic type that at the moment of commutation one portion of the said element shall have produced in it an electromotive force considerably greater than that of other similar portions of the element, but so that a balance of electromotive forces is obtained at the moment of commutation between, say, one turn, or it may be one bar, of the element of the winding and the electromotive forces in all the rest of the element. For example, by dividing the element into unequal portions, which in the case of a Gramme winding can be done by making one portion with a greater number of turns than the other, and in the case of a drum winding by making the element consist of a short chord and a long chord or diametrical winding, the two portions in each case being connected in series between the adjoining sectors of the commutator, and so constituting an element. By arranging such elements in successive order there is obtained not merely a balance or neutralization of the directions of current in the successive conductors in the neighborhood of the neutral line, but an actual preponderance of current in one direction over that in the other, whereby the armature conductor is caused to exert an actual useful magnetizing force on the magnetic system of the machine instead of the demagnetizing reaction of ordinary constructions. The several turns or bars of each element may with advantage be distributed over three or more slots in the armature core, preferably over as many slots as there are turns or bars in the element.

LETTER TO THE EDITORS.

Mutual Inductance of Three-Phase Circuits.

To the Editors of Electrical World and Engineer:

Sirs:—In a communication from a subscriber, which you sent me, and referring to an article of mine which appeared in your issue of June 23, the suggestion, as I understand it, is made that to overcome in part the effect of mutual inductance of three-phase circuits, the wires should be arranged on the poles, as shown in Fig. 1. For this, of course, the arrangement shown in Fig. 2 could be substituted for the sake of symmetry.

Using the same method employed in my article published in your issue of June 23, let the distance between the wires of one circuit be represented by unity and let $cc' = k$, (Fig. 2), Calling S with appropriate subscript the volts induced per 100,000 ampere feet of circuit at a frequency of 60 cycles, and (not to go into too much detail) considering only the absolute values of S without regard to phase relation, it can be shown that the following values of S will be obtained for corresponding values of k:

k.	$S_{ab} = S_{bc}$	S_{ac}
1	.76	1.38
1½	.43	.74
2	.28	.46

This shows that this arrangement would have larger values for the mutual inductance than were obtained in either Case 1 or Case 2 of the article referred to.

There is still another method of running two circuits on a pole, which is employed on the transmission line of a plant now in operation. The wires are run on the vertices of a hexagon, the two different circuits forming two equilateral triangles (Fig. 3). I understand that the circuits are spiraled in opposite directions. In case the circuits are not spiraled, however, it is a very simple matter to figure the effect of the mutual induction. Using the same notation employed in the article to which I previously referred,

$$S'_a = gL\,(I_a \log 2d + I_b \log d + I_c \log d)$$

where d is the length of the side of the hexagon. This reduces to

$$S'_a = gL\, I_a \log 2.$$

It is easy to see that the effect of mutual induction is equal and symmetrical throughout, and is, of course, independent of the size of the hexagon. The effect per phase $= gL\, I_a \sqrt{3} \log 2$, and the voltage effect per phase per 100,000 ampere feet of circuit at a frquency of 60 cycles is 2.76, which is much larger than the most of the other cases considered in the article.

If one circuit is spiraled one complete turn while the other runs straight, then obviously the mutual induction will be zero. The same thing will be true if *both* circuits are spiraled in opposite directions, though this is obviously unnecessary so far as overcoming any mutual induction is concerned.

Such a system of running wires would, in general, be inconvenient for use in distribution lines, where pole space is too valuable, or where it may be impracticable on other considerations to make such an arrangement. In the case of transmission lines, however, there

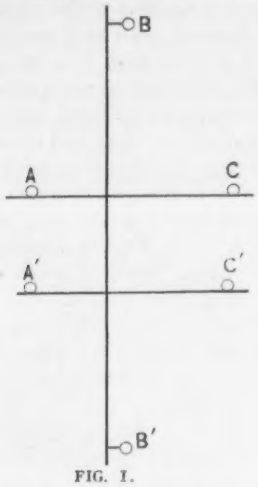


FIG. 1.

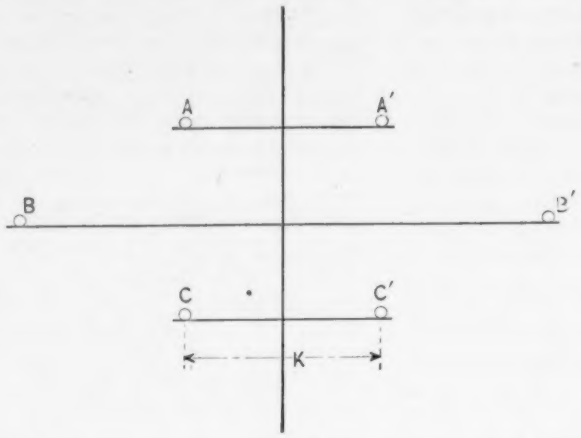


FIG. 2.

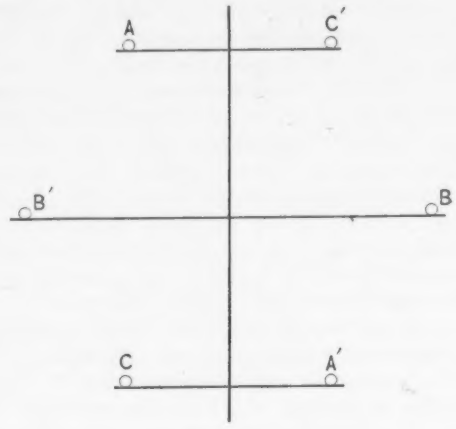


FIG. 3.

are several reasons which may render this system undesirable. In the first place, for a given minimum distance apart of the wires, the distance between the wires of a given circuit is increased by multiplying it by $\sqrt{3}$, and hence the inductance of the circuit is increased. While this may be of advantage in some cases, still it is usually not desirable. Again, it is necessary to increase the height of the poles, or else to have the wires nearer the ground than if some other arrangement were used. However, the most serious objction would be the fact of mixing the two circuits up in such a manner that an accident would be liable to disable both at once, not to mention the fact that it would be very dangerous to repair one circuit while the other was alive

AUG. J. BOWIE, JR.

BAKERSFIELD, CAL.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

Temporarily Conducted by E. F. ROEBER, Ph. D.

DYNAMOS, MOTORS AND TRANSFORMERS.

Starting Rheostats for Shunt Motors.—CUTLER.—An article, illustrated by diagrams, in which he advocates the following method of starting shunt motors. Instead of closing the circuit to the shunt field by means of the usual double-pole switch, this circuit is kept open until the rheostat lever is moved from its open circuit position to the first live button. The effect of this is to fully energize the field by connecting it directly across the line, compelling the armature current, however, to pass through the resistance of the starting rheostat. A wire leads from the first live button directly to the retaining magnet, and a connection from there through the field, winding to the opposite side of the line. When the lever of the starting rheostat is moved to the second or third button, the field current is compelled to back up through a portion of the resistance of the starter. As the motor, however, has usually started by this time, there is sufficient counter e. m. f. in the armature winding to compel practically full magnetization of the motor fields, less the very small drop due to the ohmic resistance of the part of the rheostat that is included in the field circuit. When all the resistance of the rheostat is cut out, an extra contact is made which short circuits the resistance in the field circuit, thus giving absolutely full field strength. The advantages of this method are pointed out. He further discusses the results of wrong connections between motor and rheostat, and adds some general remarks as to the starting of motors for elevators and printing presses.—*Am. Elec.*, June.

Direct-Current Boosters.—HILL.—An illustrated article on the principle of boosters. A diagram shows the connections of a series-wound, track-feeder booster, with its shunt-wound motor, driven off the main circuit. The motor should run as nearly as possible at a constant speed; the magnetic circuit must therefore be worked at a low density; the armature reaction has to be carefully limited to avoid sparking; the induction curve of a typical motor which is nearly a straight line, and an external characteristic are given in diagrams. The induction curve of the generator should also be as nearly as possible a straight line. The generator being series-wound, the question of sparking is not so difficult to deal with as in the motor, as increase of current carries with it increase of gap excitation, so that a considerable overload can be carried without trouble from sparking. With the motor this is not the case, as the excitation is practically constant, irrespective of the current in the armature, so that it is desirable to avoid the excessive currents due to the fluctuating overloads on the generator. To do this the momentum of the armatures may be utilized by allowing a difference of speed between no load and full load and by adding a fly-wheel—Lond. *Elec. Rev.*, July 6.

REFERENCES.

Motor Design.—POOLE.—The eighth article of the illustrated serial, giving a design of a two horse-power, four-polar motor with two-path drum armature.—*Am. Elec.*, June.

Induction Motors.—MORRISON.—An illustrated article discussing "some points about induction motors." In a table he gives the current taken by 100-volt, single-phase motors per horse-power of output for various efficiencies and power factors; two other tables give the results of actual tests. The starting resistances, used on motors of moderate size, are described; the connections of a three-phase starting switch are illustrated. Winding diagrams are given of a four-pole and of an eight-pole, three-phase stator and of a four-pole, two-phase stator.—*Am. Elec.*, June.

LIGHTS AND LIGHTING.

Bremer Arc Light.—WEDDING.—An illustrated paper read at the recent annual convention of the Union of German Elec. Eng., in which he gives an account of measurements made by him to test a new invention of Bremer. The principal feature of this invention is said to be the fact that a very great improvement in the economy of working of arc lamps is obtained if 20 to 50 per cent of non-conducting metallic salts, for instance, compounds containing calcium, silicium or magnesium, are added to the carbons. He has made measurements with two direct-current arc lamps of 12 and 60 amp., and an alternating-current arc lamp of 6.5 amp.; the carbons prepared with a compound containing calcium were only on the positive side of the direct-current lamps. The smaller direct-current lamp, without globe, required 546 watts, the hemispheric intensity was 4,320 candles, *i. e.*, 0.126 watt per candle; the same lamp with globe required 543 watts, the hemispheric intensity below the horizon was 2,772 candles, *i. e.*, 0.196 watt per candle; the globe shows no shades, but appears to the eye as a uniformly light disc. The larger direct-current arc lamp without globe required 4980 watts, the hemispheric intensity was 49,730 candles, *i. e.*, 0.1 watt per candle; the same lamp with globe required 4610 watts, the hemispheric intensity was 26,890

candles, *i. e.*, 0.17 watt per candle. For direct-current lamps of the Bremer type without globe, therefore, about 0.1 watt is required per candle; the lowest value of power, required for other arc lamps, which he has tested, is said to be 0.3 watt per candle, generally 0.4 to 0.5 watt is required per candle, so that the Bremer lamp is claimed to yield three or more times the light of other arc lamps for the same consumption of power. With the alternating-current lamp he found that about 0.5 watt is required per candle, but he believes that the economy of working can be much increased in this case; also in this lamp only on one side the specially-prepared carbons were used. The description of the construction of the Bremer lamp is rather short. Two carbons—or in the larger lamps several pairs—are placed parallel to each other in vertical positions, instead of one being over the other. The arc between the ends is blown downwards (under the influence of the magnetic field produced between the parallel carbons); the greater the current, the more the arc is blown downwards; this may be regulated by the influence of an artificial magnetic field. For lighting the lamp an electromagnet in shunt is employed, as usual, for bringing the carbons into contact. During the consumption of the carbons the distance between them is kept constant by shoving them along continually and not step by step; "this is accomplished by the weight of the carbons and an auxiliary weight," but it is not said how it is done; the complicated and expensive devices, used now in arc lamps for that purpose, are dispensed with. While in other arc lamps the light emanating from the arc is only a very small part of the whole light given out by the lamp, in the Bremer lamp the arc is considerably greater and yields a larger percentage of the whole light. Above the carbons there is a conical brass surface of about 2 inches height, in order to prevent a quick escaping of the heat developed between the carbons, so that higher temperatures and a slower consumption of the carbons are obtained. The cross-section of ordinary arc carbons is three times that of Bremer carbons, while the consumption of Bremer carbons, measured by the length consumed, in a certain time, is twice that of ordinary carbons. The calcium compound, contained in the Bremer carbons, is precipitated in fine powdered form on the upper conical brass surface and yields an excellent reflector. The light given out by the Bremer lamp is said to contain an abundance of rays of the yellow and red part of the spectrum, and to be less absorbed by steam than ordinary arc light.—*Elek. Zeit.*, July 5.

Open and Enclosed Arc Lamps.—WAIT.—An article giving a general comparison of open and enclosed arc lamps for street lighting. He gives several diagrams made up by taking the average of curves published by several authors and of curves made in the testing-rooms of lamp manufacturers. The figures give the intensity of light in candle-power of three different types of direct-current lamps, also some curves from alternating current lamps, also the intensity of illumination at the street surface. He points out the fact that the public acquiesces in the substitution of 450-watt enclosed, direct-current lamps in place of open arcs, and discusses how much will be saved in the cost of operation by the substitution. He finds that the encased lamp in itself will save something less than $10 per lamp per year for all-night running, and that this difference would increase with shorter hours and also with lower candle-powers. This saving is a clear gain if the installation is a new one. With an old plant it will be necessary to increase the investment to effect this saving. The increased investment eats up a good part of the saving due to the use of enclosed lamps, so that the bulk of the gain must come from greater economy in the generating plant and that in a great many cases it will not pay to make the change unless a marked saving inside of the station can be figured out. The saving in the station from the change can often be brought up to $20 or $30 a year, in which case there is no question about the advisability of changing to enclosed lamps.—*Am. Elec.*, June.

POWER.

Electric Power in Workshops.—A long abstract of a committee report presented at the convention of the American Railway Master Mechanics' Assn., giving a comparison of the relative advantages of shafting and of individual electric motors for tool driving in shops. The relative economy in cost of power itself, the relative convenience of operation and installation, and the relative effect upon shop output and cost of labor are discussed. In a table the power required for different machine tools is given, and suggestions are made upon the manner of installing an electric transmission plant. The following conclusions are arrived at. In a small shop, consisting of practically one building, having an equipment of small tools for light work only, electric transmission will not be found a paying investment; in such a shop, however, an electric-lighting dynamo will be a convenience and may be utilized to run a few labor-saving electric tools, such as a cylinder-boring outfit, a turn-table motor, etc. In an extensive railway shop plant the installation of a central power station and electric transmission will always be found advisable, as it will not only result in the most economical system in respect to operation, but will make possible far more important shop economies, namely, an increase in quantity and quality of output and a reduction in cost of handling the same. The installations of the Westinghouse Air Brake Co., the Oelwein shops of the Chicago Great Western R'y, the General Electric Co., and the Baldwin Locomotive Works are briefly described.—*Eng. News*, July 12.

Refuse Destructors.—HIGHFIELD.—A brief article giving an account of the experience obtained at St. Helens. The lighting and traction plant contains four engines with direct-coupled generators of a total capacity of 600 kilowatts. A fifth engine is on order with a capacity of 300 kilowatts. Adjacent to the electric plant the health committee has erected a destructor plant which consists of two furnaces, each having two cells of the Beaman and Deas principle. He gives the results of a test made by the electrical engineer; the very high results attained in this test could not be kept up in practice, as the labor would be too heavy, and the depreciation of the furnaces too great. He gives another table showing the results attained in ordinary working during May. The average weight of refuse burnt per week is 143.9 tons, that of clinker and ash 40.4 tons, that of mortar made per week 15.1 tons, that of refuse per shift of 9 hours, 13.1 tons. The average units generated from steam per week are 7062; those generated per ton burnt 50; the average wages per ton burnt are 28.5 cents. The destructor plant has now been working since January and the noted results are maintained steadily, week by week. No coal whatever is used in the destructor furnaces.—Lond. *Elec. Rev.*, July 6.

Electric Power for the Small Consumer.—An editorial note on an experiment made by two Hungarian companies in the neighborhood of Budapest, in supplying electricity for motive power for industrial purposes in cottages and small homesteads. Reference is made to the opinion expressed by Lord Salisbury that the advent of electric power would revolutionize industrial methods, decentralizing industry from the factory to the home. Cheap power, however, is not the sole consideration, nor, indeed, the principal consideration in this question; the distribution of the raw material and the collection of the finished products play an important part.—Lond. *Elec.*, July 6.

REFERENCES.

Steam Engineering in Central Stations.—Several articles on this subject; on the selection of an engine for a power station, by Carpenter; on boilers for electric power plants, by Douglass; on stoking in central stations, by Hobart; on handling coal in central stations, by Francis; on steam plant auxiliaries, by Percy; on the arrangement of central station piping, by Ennis.—*Am. Elec.*, June.

Arrangement of Steam Piping in Central Stations.—ENNIS.—A résumé of the latest practice in the arrangement of piping between boilers and engines and pumps.—*Amer. Elec.*, July.

TRACTION.

Tramway Profits.—GADSBY.—An abstract of a paper read before the Brit. Tramways and Light R'y Ass'n. It is generally possible by increased services to increase the gross receipts. The operating expenses do not increase at the same rate as the mileage, and generally at a less rate than the receipts. The receipts per car mile on British tramways vary from 14 to 50 cents; he considered that for electric and cable lines any rise in receipts per car mile above 18 cents should be at once checked by an increased mileage; in the case of horse tramways the limit should be 24 cents, and for steam tramways 28 to 30 cents. He gave a calculation to show that by increasing the mileage a larger clear profit can be made, while keeping down the receipts per car mile. He gave comparative tables showing the average working expenses of horse, steam, and electric traction. With horse trams the average total working expenses amount to 19 cents per car mile, with steam to 21.5 cents, with electricity to 10 to 12 cents. He concludes that electric traction constitutes the readiest means of increasing the receipts, and at the same time reducing working expenses.—Lond. *Elec. Eng.*, July 6.

Storage Batteries for Automobiles.—HANCHETT.—An article, in which he shows in a numerical example, how to select a suitable storage battery for a given automobile. It is required to provide a battery to propel a two-passenger vehicle 30 miles at the rate of 10 miles per hour on level road. The calculation must therefore be

based upon the three-hour discharge rate; it is known from experience that a capacity of 120 watt hours per ton mile is required. He estimates the weight of the different parts of the automobile; the weight of the motors and of the battery are unknown, and it is assumed that a good battery gives 6 watt hours per lb. of weight and that automobile motors weigh 150 lbs. per kw-input. The mathematics used to solve the problem are very simple. He finds the weight of the battery at 334 lbs. and that of the motor at 100 lbs., its kw-capacity being 668.—*Am. Elec.*, June.

Tramways of Nice and Littoral.—An illustrated description of this electric railway which, when finished, will be 93 miles in length. Power is taken from water-power 18 miles distant and is transmitted at 10,000 volts. On certain streets in the city a conduit system, similar to that of Paris, is used, but elsewhere the trolley system is employed. At the main power station there are three 500 kw-generators, giving three-phase current of 25 cycles at 10,000 volts. The drop of the transmission line to Nice is 10 per cent. At Nice a portion of the current is transformed to 5000 volts and transmitted to two sub-stations. The rest of the power is taken to the railway substation, where it is converted to 550 volts direct current.—*St. R'y Jour., Int. Ed.*, July.

REFERENCES.

Tramway Exposition.—The conclusion of the illustrated description.—Lond. *Elec. Rev.*, July 6; a continuation of the description in Lond. *Elec. Eng.*, July 6.—An editorial on "Lessons of the tramways exhibition," discussing mainly the design of street railway cars, which, in present practice, are ordinary horse cars, only somewhat larger and fitted with motors, and with the worst faults of the horse cars magnified in an excessive proportion; reference is made to the so-called maximum traction truck, which shows that this subject is now not being neglected. Lond. *Elec. Rev.*, July 6.—A brief communication by Witting Bros., on their single-phase motor and others of their exhibits, in Lond. *Elec.*, July 6.

Germany.—Some notes from Germany stating that the franchises of the principal railway company of Berlin have been extended from 1922 to 1949 by the Prussian Minister of Public Works, but not by the city, which is understood to mean that the city will attempt to acquire control of the property in 1922. Extension of the suburban service is made in the larger cities of Germany. He gives a list of the standard-gauge steam railroads which have made experiments with storage-battery motor cars, and describes in detail the electric motor car used on the Belgian State roads; there are five of these cars in active service weighing 46 tons each, of which the accumulators weigh 12 tons. The paper by Teichmueller (Digest, June 23) is abstracted.—*St. R'y Jour., Int. Ed.*, July.

Double-Current Generators for Railways.—A note on the scheme of the Massachusetts Electric Co. to introduce three-phase transmission for some of their lines. At Salem two 800-kw, double-current generators will be installed, direct coupled to engines. These machines may be run in parallel with the three 300-kw, direct-current machines now in service there. If any trouble develops, the double-current generators will be set on a different set of bus bars.—*St. R'y. Jour.*, July 7.

Light Railway Schemes.—A statistical article giving some information on light railway schemes in Great Britain. While the total number of applications show a considerable falling off, compared with 1899, the proportion of the electrical projects is maintained.—Lond. *Elec.*, July 6.

Glasgow.—YOUNG.—An abstract of a paper read on "the function of modern tramways," especially in large cities. He gave an account of the development of the municipal tramway system of Glasgow, which is now being converted from horse traction to the trolley system. A great traffic was created by means of one-cent fares, the average distance for which was about half a mile; the lowering of the fares seems to have increased the net revenue. The Tramway Committee had had before them for some time a proposal for next year to extend the one-cent stage, which would make the two-cent stage about 3 miles.—Lond. *Elec. Eng.*, July 6.

Swansea.—A well-illustrated description of the recently-opened tramway system of Swansea; the trolley system is used.—Lond. *Elec. Eng.*, July 6.

Farnworth.—A brief, illustrated description of the double-track tramway lines of Farnworth, which are a continuation of the Bolton tramways and have been converted from horse traction.—Lond. *Elec. Rev.*, July 6.

Single-Rail Electric Railway.—An illustrated description of the line between Barmen and Elberfeld, noticed in the Digest Sept. 16, Dec. 23, May 5.—Lond. *Elec.*, July 6.

Southampton.—A description of the municipal tramways of Southampton, which were already noticed in the Digest.—*St. R'y Jour., Int. Ed.*, July.

Street-Car Building.—DAVIS.—A continuation of his serial. In two tables and two plates different parts of closed and open standard cars, used in Boston and in Brooklyn, are described in detail.—*St. R'y Jour.*, July 7.

Electric Car Fuses.—CHARLES.—Two elementary articles, pointing out the various troubles which may cause electric-car fuses to blow.—*Amer. Elec.*, June, July.

Street Railway Strike.—An article on the recent strike in Berlin.—*St. R'y Jour., Int. Ed.*, July.

INSTALLATIONS. SYSTEMS AND APPLIANCES.

Joint Transmission of Direct and Alternating Currents.—A brief article referring to the paper of Bedell, which was published in abstract in ELEC. WORLD AND ENG., June 13. The paper is said to reveal a new and striking discovery, which, no doubt, will have many useful applications, as it seems that we have in it the basis of an all-around system of supply to meet the wants of all classes of consumers. Some questions are asked. As the resultant current will be asymmetrical about the axis and may even, under certain conditions, be unidirectional, what effect will this have upon the hysteresis and eddy losses? In driving direct-current motors, will there not be serious eddy-current and hysteresis losses in the iron poles and cores? Will it be possible by merely inserting a choking-coil in the circuit to charge accumulators from the mains? Finally, it is pointed out that the resultant pressure is raised by 40 per cent; if this were done on either a direct or alternating system of the ordinary type, precisely the same saving would be effected as in Bedell's system; the writer believes that this saving appears to be essentially due to the increased pressure and cannot be claimed as an inherent property of the system.—Lond. *Elec. Rev.*, July 6.

Power-Station Design.—DAWSON.—A paper read before the Brit. Tramways and Light Railways' Ass'n. He does not recommend the combination of existing lighting and traction stations, and says that good results cannot be expected. The case is, however, entirely different where a combined station has been designed by experienced traction engineers for both traction and lighting, and the best results are then obtainable. He shows differences between a lighting and a traction station. A lighting station must in three months earn enough money to pay working expenses and to pay interest and allow for depreciation and sinking fund for a whole year, while a traction plant has from nine to eleven months to do the same thing. A lighting plant is, on an average, practically at a standstill 18 hours a day, while a traction plant is running 18 to 20 hours per day. In a traction station a far greater figure is cut by the cost of generation, pure and simple, than in a lighting station, and the question of interest on capital, expenditure, and sinking fund is relatively smaller in the former than in the latter. He gives figures as the result of actual experience. The total cost of generation of a kw-hour for lighting, comprising fuel, oil, waste, and stores, wages and maintenance, is 1.4 to 9.6 cents, while the cost for traction is 0.3 to 2.3 cents. He says that in a traction station much greater capital expenditure is justified. A single station is preferable, as the wages and the waste of coal, etc., are far greater in several than in one station. For anything above 5,000 kw-capacity, one polyphase station operating synchronous converter sub-stations is the best. Large units are also always advisable. He gives a table of the sizes of engines recommended for use in power stations. From a careful comparison of many existing systems, he concludes that the total cost of power, all fixed charges included, for one large station, as compared to that for two or more smaller stations, together equal in power to the larger one, is from 30 to 75 per cent lower.—Lond. *Elec. Rev.*, July 6.

Combined Management of Tramway and Lighting Departments.—QUINN.—An abstract of a paper read before the Brit. Municipal Elec. Ass'n. He assumes a town with separate generating stations for lighting and traction, and shows that a combined management of both departments is advisable. The lighting engineer should also be the engineer of the traction plant. The design and working of an electric traction system is almost entirely an engineering problem, and the man best qualified to carry out this work is the competent central-station engineer. The discussion which followed is briefly abstracted.—Lond. *Elec. Rev.* and *Elec. Eng.*, July 6.

Combined Lighting and Traction Stations.—An article calling attention to the difference of opinion about the question whether a combined station is advisable. Glasgow and Cardiff are erecting separate stations, while Manchester and Southampton are combining the two systems, even though in the latter case the lighting supply is with alternating current. For small townships, where neither lighting, nor power, nor traction, is likely ever to become of large dimensions, it is thought that there can be no doubt whatever as to the advisability of combining the works, as far as possible, and placing the whole under the supreme control of an electrical engineer; a smaller engineering staff will thus suffice for the joint undertakings than if they were separate, and their time will be employed to better purpose. On the other hand, when both operations are carried on upon a large scale, it is thought that the engineers must specialize, as one man cannot be responsible for the two extended departments. Similar opinions regarding the advisability of combined stations for towns of moderate size are expressed in communications by Snell, Mountain and Highfield, which are reprinted. Finally, it is pointed out that in cases where the demand becomes so large as to render necessary the establishment of a high-pressure generating station, removed from the centre of the area of supply, there is a simple way in which to enable the same main generators to supply lighting, traction and other loads, even of the most variable character, without detriment to the lighting pressure: that is by the use of synchronous motor-generators for the lighting circuits.—Lond. *Elec. Rev.*, July 6.

Reduction of the Light-Load Losses in Alternating-Current Supply.—BOOT.—A paper read before the Brit. Municipal Elec. Ass'n. He deals at some length with the no-load losses in transformers, with the improvements made in recent years in transformer design, and with the switching in and out of transformers. In conclusion he says that in order to reduce the light-load losses, the low-tension distributing network should be inter-connected, each sub-station interconnection being by a fuse on both poles; the supply can be given by one transformer, preferably situated at the works, and so arranged as to feed the whole network; in each sub-station, switch-gear must be arranged to disconnect the primary from the source or sources of supply, and the secondary winding from feeding or being fed by the low-tension network; unless automatic switches are used, it is the main superintendent's duty to arrange with certain men on their way to work to open the switches and switch in the transformers at sunset; the feeders should be so arranged that during the hours of daylight they can be tested and all pressure removed. The discussion which followed is also abstracted.—Lond. *Elec. Eng.*, July 6.

Power Plant of the New York Factory of the Western Electric Company.—A profusely-illustrated description of the 110-volt power plant in this factory. This potential was employed because it was less expensive to install the huge copper conductors required than to rewind the large number of 110-volt motors already in use. The transmission distance being so short, the size of the conductors was based upon the heating limit and not upon the drop, so that the cross section was larger than it would have been had the drop in the lines been the only consideration.—*Amer. Elec.*, July.

REFERENCES.

Improvements in Electric Supply Plant.—Illustrations, with brief description, of the latest patterns of electric supply station and transformer plant and apparatus, made by Fowler & Co. The illustrations show a form of single-pole, lever-type shutter switch, designed to work in connection with large currents at high voltage; a plan of the top of an underground transformer box for use in distribution systems supplying power over a scattered area, or where the demand is not likely to be very heavy at any given point; also an underground key switch for connecting or disconnecting transformers.—Lond. *Elec.*, July 6.

Lightning Arresters.—An illustrated description of the Wurts lightning arresters for alternating current circuits.—*Elec. Rev.*, July 11.

Small Central Stations.—MATHER.—An illustrated article on the electrical equipment for small central stations. He first deals with the three-wire, direct-current system, and discusses the use of motor balancers and storage batteries; he then treats the two-phase, alternating-current system, and finally a combined system, in which double-current generators give 500 volts direct current at one side for motor and arc lighting circuits, and at the other side two-phase alternating currents for the incandescent service. The advantages of the different systems are pointed out.—*Am. Elec.*, June.

Isolated Plant.—A brief, illustrated description of the electric plant for lighting the Doxford Hall at Northumberland, and for supplying current to the electric irons in the laundry, to an electric horse-clipping machine, and to various motors for pumping and other purposes.—Lond. *Elec. Rev.*, July 6.

WIRES, WIRING AND CONDUITS.

Cables for Distribution Networks.—WILKINSON.—An abstract of a paper read before the British Municipal Elec. Ass'n on "the distribution of electricity." He thinks that probably the advent of higher-voltage lamps, and the consequent raising of the electrical pressure upon the distributors, will lead to simple concentric mains, entirely superseding both the three-core and triple mains for alternating-current distribution purposes; for high-tension distribution, concentric mains, with the outer conductor earthed at the station, have demonstrated their superiority over side-by-side cables, both in point of efficiency and safety. He strongly advocates more uniformity of design and standardization in joint boxes, disconnecting boxes, house-service boxes, terminal boxes, and their accessories. In joint boxes for concentric cables the method of clamping up the outer conductors upon the insulation of the inner conductors should be condemned; the makeshift of slipping a split ferrule in between the outer conductors and the inner insulation should also be abandoned. In every case the outers of concentric or triple-concentric mains should be bent out at right angles, radiating from the centre of the cable, and be securely clamped between two disks of metal, which also form the necessary connections in the joint; by this means a good contact is maintained between each and every strand of the outer conductor. If these disks of metal are made whole, the centre conductor requires to be cut in order to get the disks into position, which is not good practice. To avoid it, the disks should be made in halves, the division line of the front disk being set at right angles to that of the back disk, thus securing rigidity and good conductivity when fixed. For the same reason, all joint boxes for mains should be made in halves, *i. e.*, divided horizontally in the plane of the cable; otherwise the mains have to be cut to get the joint boxes on, which is a bad method. He protests against the far too lavish use of compound in joint boxes; the connections within the box should be enclosed in a light internal box, preferably of incombustible material, to keep the compound off the connections, and the compound should be run in solid between this internal box and the outer box. He would like to see the custom of using wood or fibre boards in joint boxes superseded by the use of earthenware or other incombustible materials having satisfactory insulating qualities.—Lond. *Elec. Rev.*, July 6. The paper is also discussed in a separate article in this journal.

Fuse Wire.—A brief note. Of the various materials used, tin and copper are most usually found. The real disadvantage of the tin fuse is said to be a mechanical one; the fuse wire is soft, and when screwed up it undergoes deformation; further, with the slight expansions and contractions of the metallic parts of the fuse, due to the heat of the current in the fuse wire, the portion of the same under the terminal is gradually flattened still more, until it is a loose fit. The best way to overcome this difficulty and still retain the advantages of the low-melting point of the tin over that of copper, is to provide heavy brass washers, with a broad sawcut on one side of the same, into which the tin fuse wire can be soldered. These brass washers give a good connection with the terminal blocks, and also sufficient surface to prevent local heating.—Lond. *Elec. Eng.*, July 6.

REFERENCE.

Wiring Fire-Proof Buildings.—JONES.—An article on the wiring of the Merchants' Loan and Trust Building of Chicago.—*Wisc. Eng.*; abstracted in Lond. *Elec. Eng.*, July 6.

ELECTRO-PHYSICS AND MAGNETISM.

Magnetic Field Due to a Moving Electric Charge.—CRÉMIEN.—An account of an experiment which appears to be not in agreement with Maxwell's theory. According to Maxwell, a body carrying an electrostatic charge and moving with a certain velocity, should produce a magnetic field equivalent to that of a certain conduction current. Experiments made by Rowland seemed to confirm this prediction. Lippmann has pointed out, as a logical consequence of Maxwell's view, that electrified bodies would be moved by every change in the intensity of the surrounding magnetic field, but he failed to discover any such motion. Crémien made a charged disk rotate in the centre of a large coil and in the same plane; the charging of the disk would be equivalent to the establishment of a circular current, and should therefore produce an induced current in the coil; but no

such effect was produced, whether the disk was left bare or lacquered, or cut into three independent and insulated sections.—*Comptes Rendus,* June 5; abstracted in Lond. *Elec.,* July 6.

Uranium Radiation.—BECQUEREL.—An account of experiments made with uranium. He found that the rays emitted by uranium were deflected to some extent; he believes that these deflected rays are due to actinium; they can be removed by treating the uranium chloride with barium chloride. Radio-active barium sulphate is produced, and a purified uranium salt remains. Further purification makes no difference, so that it is probable that uranium has a definite though feeble radiation of its own.—*Comptes Rendus,* June 11; abstracted in Lond. *Elec.,* July 6.

Heat Due to Cathode Rays.—VILLARD.—A French Academy note calling attention to the heating up of the cathode which always accompanies the formation of cathode rays. He describes an experiment with two filaments in a tube, each filament being connected to one terminal of a Ruhmkorff coil; the current is allowed to pass only in one direction; the cathode filament then yields incandescent light; this can be done at pressures up to one atmosphere by using metallic instead of carbon filaments. The difference of potential required to produce incandescence by the cathode effect is much higher than that required by the Joule effect, but the current required is much less. Some of Tesla's incandescent phenomena are probably due to cathode heat.—*Comptes Rendus,* June 11; *L'Eclairage Elec.,* June 30: abstracted in Lond. *Elec.,* July 6.

REFERENCES.

Röntgen Rays.—ROLLINS.—A continuation of his long, illustrated serial. He gives notes on tubes for generators of low potential, and replies to the question whether the ether does conduct by stating that "the ether is 'disassociated' when sufficient energy is applied, and that 'when disassociated,' its particles forming new combinations with the differentiated ether we call matter, its properties are so changed as to give rise to the phenomena we call electricity and conduction." Conduction is a phenomenon of matter. The maximum X-light arises in the field of greatest ether strength. He also describes an X-light tube having a target to rotate in two planes, and with a reserve cathode.—*Elec. Rev.,* July 11.

Viscosity of Liquids in an Electrostatic Field.—PACHER and FINAZZI.—An account of careful experiments which appear to show that the viscosity of a liquid is not altered by immersing it in an electrostatic field; this is in agreement with the experiments of Koenig, while Duff and Quincke had found different results, although with methods which have been objected to.—*Nuovo Cimento,* April; abstracted in Lond. *Elec.,* July 6.

ELECTRO-CHEMISTRY AND BATTERIES.

Electro-Chemical Equivalent of Carbon.—PEASE.—The mean of five experiments on the loss of weight of a carbon anode in fused potassium hydroxide in an electrolytic cell with an iron cathode gave 3.32 as the equivalent of carbon, while Coehn has found the value in sulphuric acid to be 3.0. Carbon thus comports itself in these electrolytes as a quadrivalent element.—*Jour. Phys. Chem.,* v. 4, p. 38; abstracted in *Tech. Quart.,* June.

Electrolytic Reduction of Potassium Chlorate.—VOEGE.—An account of experiments in which he studied the reduction of potassium chlorate under as varied conditions as possible. The reduction is greater in acid than in alkali solution, and varies with the strength of acid; it increases greatly with the temperature, and increases also with decreasing current density; this last influence, however, varies with the nature of the metal used for the electrodes, copper, zinc, cadmium and platinum having been studied.—*Jour. Phys. Chem.,* v. 3, p. 577; abstracted in *Tech. Quart.,* June.

REFERENCES.

Electrolytic Deposition of Brass.—MORGAN.—An attempt to explain the process of brass plating on the basis of the osmotic theory of the galvanic cell.—*Jour. Am. Chem. Soc.,* v. 22, p. 93; noticed in *Tech. Quart.,* June.

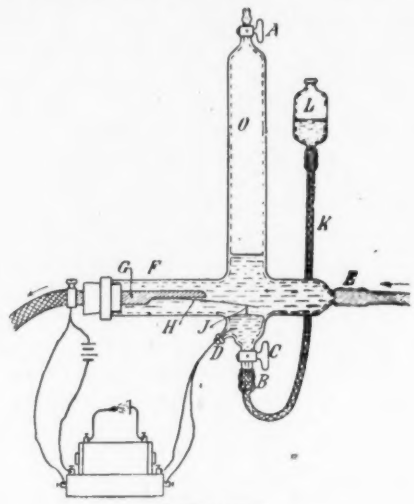
Electrolytic Production of Soda and Chlorine.—HOBART.—The fourth article of his serial, discussing the Grotthus theory of electrolysis.—*Am. Elec.,* June.

Storage Batteries for Automobiles.—SIEG.—A translation of the German article, abstracted in the Digest, June 16.—Lond. *Elec.,* July 6.

Primary Batteries.—OVERBURY.—An article on primary battery troubles. In carbon-zinc cells the structure and porosity of the carbons and the degree of purity of the zinc, of the water and of the excitant are of great influence.—*Am. Elec.,* June.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Interrupter.—GRIMSEHL.—A description of an interrupter, which is illustrated in the adjoining figure. There is a cruciform glass tube; the vertical tube, *O,* is closed by the cocks, *A* and *C,* and is by the pipe, *K,* in communication with the vessel, *L,* containing mercury. The one end, *E,* of the horizontal tube is connected to a spigot, the other end is closed by an organ pipe, *G,* the reed, *H,* being provided with a small piece of platinum wire, *J.* Mercury is filled into the tube through the cock, *C,* until the platinum wire, *J,* just touches it, and then the cock, *C,* is closed and water is run slowly from the spigot through the horizontal tube. As long as the quantity of water is small, it flows off through the organ pipe; but when the spigot is further opened, so that more water is flowing into the horizontal tube than is possible to flow off through the organ pipe, the air in the upper part of the vertical tube, *O,* is compressed, and at a certain pressure the organ pipe begins to sound, the reed vibrates with a certain frequency, and the platinum wire attached to the reed produces as many interruptions as there are vibrations of the reed. The resistance of the water is so great that the current can be regarded as nearly fully interrupted. The continually-flowing water cools the contact point and removes any parts of oxydized mercury from the contact point. The quantity of mercury removed by the mercury is so small that it takes some hours before it becomes necessary to adjust again the



INTERRUPTER.

level of the mercury. The pressure of the water may be small and the consumption of water is trifling.—*Elek. Zeit.,* June 14.

Electrical Measuring Instruments.—STEVENS.—A Franklin Institute paper, giving an outline of the different forms of commercial direct-reading indicating instruments, now in use. He strongly advocates the use of electromagnetic instruments with gravity control for switchboard use whenever the conditions render them applicable; the fact that instruments constructed on the electromagnetic principle contain no material subject to change or deterioration, coupled with the fact that they can be built solidly and substantially, and controlled by gravity in place of a spring, renders them exceedingly reliable in practice; if their calibration is correct when first installed, there is no reason why the calibration should change with time. He speaks against the use of hot-wire instruments; the fact that they are extremely susceptible to variations of external temperature, which must be compensated by mechanical means or by providing auxiliary heating strips, is claimed to signify an error in principle; other objections are said to be the constant change of zero, the inability to stand an overload, and the amount of current required to operate the instrument; as a shunt ammeter, the hot-wire instrument is claimed to be a distinct failure. With electrostatic instruments it is impossible to obtain a low reading; they cannot be made dead-beat without introducing elements liable to seriously interfere with their accuracy; they are affected considerably by external influences, particularly by static charges, for whch it is impossible to provide a shield. He then discusses briefly the types, based upon the principle of the tangent galvanometer, of the dynamometer, of the d'Arsonval galvanometer, and the electromagnetic principle; these four types are said to be

essential for some class of measurement, and for any particular line of measurement the most suitable system should be selected. Electromagnetic instruments, containing a mass of moving iron, can be constructed so that errors of lag and hysteresis, if they are present, are so small as to be negligible; to accomplish this, every part of the instrument should be in proportion with reference to all other parts; the instrument should be carefully shielded from the influence of external fields; in no case should two masses of iron be employed.—*Jour. Frank Inst.*, July; reprinted in *Elec. Rev.*, July 4, 11.

Clark Cell.—BARNES.—A paper giving the results of experiments on the change of hydration of zinc sulphate crystals indicated by the change in the temperature coefficient of a Clark cell in the neighborhood of 39 degs. C. The temperature coefficient of cells of various forms was measured from 15 to 50 degs., and formulæ for the e. m. f. deduced for various intervals. The e. m. f. curves for cells containing the hepta and hexahydrates of zinc sulphate cross at 38.78 degs. C., which therefore corresponds to the transition temperature. From solubility experiments the transition temperature was found to be 39.95 degs. The difference is explained by secondary influence due to the presence of the mercurous sulphate in the Clark cell.—*Jour. Phys. Chem.*, v. 4, p. 1; abstracted in *Tech. Quart.*, June.

REFERENCES.

Frictionless Motor-Meter.—EVERSHED.—An illustrated abstract of the paper noticed in the Digest, June 16, 30, July 7.—*Elec. Rev.*, July 11.

The Importance of Photometry to Central Stations.—REED.—Continuations of the illustrated article, urging the adoption of photometric measurements for central stations, and the custom of giving free incandescent lamp renewals (Digest, May 19).—*Am. Elec.*, June, July.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Duplex Wave Telegraphy.—TURPAIN.—A French Academy note, describing a system of superimposing a wave message upon an ordinary direct-current telegram without interference, so that the same wire is used for two simultaneous messages. "The wave message is sent by ordinary wire waves, but in order to prevent it rushing into the Morse electromagnet and destroying its insulation, the Morse receiver is enclosed in a metallic screen in contact with the magnet winding, and an electrolytic cell or an iron coil is also added to the receiving apparatus in order to force the waves into the line wire." Tests of this system are said to have been successful, but no guarantee appears to be given that existing telephone circuits would not be influenced.—*Comptes Rendus*, May 14; abstracted in Lond. *Elec.*, June 29.

Typewriting Telegraph.—An illustrated description of the Steljes typewriting telegraph, which is a modification of the Wheatstone A B C instrument. Its mechanism and action are very simple, compared with that of the Hughes instrument, but the speed of working is slow. While in the Wheatstone instrument the pointer of the receiver is moved in synchronism with the pointer of the transmitter by means of alternating currents, in the Steljes instrument a type wheel takes the place of the pointer. The escapement driving the type wheel is moved by a pair of electromagnets similar to those of a magneto-bell, the power being obtained by a weight or a spring. The simple mechanism used to move the type wheel against the paper tape at the moment the current stops, is described.—Lond. *Elec.*, June 29.

REFERENCES.

Cable-Repairing Steamer.—A supplementary description of the Eastern Telegraph Co.'s new cable-repairing steamer, John Pender, noticed in the Digest, Apr. 28.—Lond. *Elec.*, July 6.

Interior Telephone Systems.—HENRY.—The second and third of a series of articles, describing the principles of interior telephone systems (Digest, May 19).—*Amer. Elec.*, June, July.

MISCELLANEOUS.

Union of German Electrical Engineers.—A preliminary account of the proceedings of the eighth annual convention, held in Kiel, from June 17 to 20. The number of members is 2874. Provisional regulations for tramways and for lighting installations in theatres and storage houses were accepted. Hartmann, of the firm of Hartmann & Braun, was elected president. Many papers were read, one by Granert on the electric installation of warships; another by Wedding on the new Bremer arc lamp, which is said to give twice or three times the illumination of an ordinary arc lamp for the same energy; another by Dettmar on the necessity of regulations for tests of machines. The papers will be abstracted under the different headings of the Digest as soon as they are published.—*Elek. Zeit.*, June 28.—The first part of a long, illustrated account of the proceedings in Lond. *Elec. Eng.*, June 29.

REFERENCES.

Electricity for War Purposes.—DARY.—An article on different kinds of electric apparatus for use in the war.—*L'Elec.*, June 23.

Educational.—ALDRICH.—An abstract of a paper read before the Society for the Promotion of Engineering Education, on operating work as a feature of electrical laboratory training.—*Elec. Rev.*, July 4.

Manufacturing Plant.—A long and fully-illustrated article on the new plant of the English Electric Manufacturing Co., which was already in the Digest, July 14.—*St. R'y Jour., Int. Ed.*, July.

Manufacturing Plant.—An illustrated article on the Westinghouse electric factory at Havre, France, described in the ELEC. WORLD AND ENG., July 7.—*St. R'y Jour., Int. Ed.*, July.

Storage Battery Manufacturing Plant.—A translation in abstract of the German article on the manufacturing plant of the Oberspree Co., Noticed in the Digest, May 19.—Lond. *Elec.*, June 29.

Educational.—SCHUSTER.—A description of the recently-opened physical laboratory at Owens College, Great Britain.—Lond. *Elec.*, July 6. An account of the proceedings of the opening ceremony in Lond. *Elec. Eng.*, July 6.

Metal Market.—Diagrams showing the fluctuations of the price of zinc, lead, iron, tin and copper during the month of June.—Lond. *Elec. Rev.*, July 6.

Paris Exposition.—A short description of the trolley line connecting the Exposition grounds with Vincennes.—*St. R'y Jour.*, July.

DURAND.—A brief, illustrated description of the U. S. machinery building at Vincennes, and the first part of an article on American exhibits.—*Elec. Rev.*, June 27.

An illustrated article on Brown, Boveri & Co.'s exhibit.—Lond. *Elec. Rev.*, June 29.

MONTPELLIER.—A description of the electric kitchen of the restaurant La Feria in the Spanish part of the Exposition.—*L'Elec.*, June 23; another description of the same installation in *L'Ind. Elec*, June 25.

DURAND.—An illustrated article on the German electrical exhibits. —*Elec. Rev.*, July 11.

An illustrated description of a generating set at the Exposition, the engine being made by Galloways, the shunt-wound, multipolar dynamo giving 1400 amperes at 230 to 250 volts, by Mather and Platt.—Lond. *Elec. Rev.*, July 6.

A long, well-illustrated description of the power-generating plant of the Exposition, comprising typical examples of European engineering.—*Am. Elec.*, June.

DONNER.—An illustrated description of some of the principal engines and alternators exhibited in the French and foreign machine rooms of the Electricity Building.—*Am. Elec.*, July.

New Books.

PHOTOMETRICAL MEASUREMENTS. By Wilbur M. Stine. New York: The Macmillan Company. 270 pages, 67 illustrations. Price, $1.60.

This is a treatise on the theory and practice of photometry, showing evidence of great care in its compilation. The subject is handled in a manner which makes the book equally valuable to those who are following the general practice of the art and to those who are desirous of studying the theory of this little-understood science.

While written with special reference to the measurement and comparison of electric lamps, the chapters on the numerous forms of photometer screens and photometers themselves, and that on the various standards, laboratory and commercial, are of universal application and of much value, not only because they set forth the numerous practicable designs, but by stating the drawbacks of the more prominent of those which at first glance would seem desirable, but which are found unsuited for use in the complicated work of photometrical determinations.

The chapter on secondary standards, especially that portion treating of the incandescent lamp when so used, is elaborately treated and will be found to contain many points of interest. The photometry of

arc lamps is also handled with great thoroughness, and those who have occasion to start work in this difficult branch will be well paid by its careful perusal.

In spite of the comprehensive scope of the volume, the matter is much condensed, this being rendered possible by the elaborate and excellent system of references giving the authority for the statements made in the text, which enables the student who desires to obtain a thorough mastery of details to follow the subject through all its branches without burdening the manual with much that is of questionable utility to the practical man.

The book will make for itself a permanent place in the literature on the subject.

GENERATOREN, MOTOREN UND STEUERAPPARATE FUR ELEKTRISCH BETRIEBENE HEBE UND TRANSPORTMASCHIEN. By Dr. F. Niethammer. Berlin: Julius Springer. 423 pages, 805 illustrations. Price 20 marks.

The title of this work—Generators, Motors and Controlling Apparatus for Electrically-Operated Elevators and Cranes, Stationary and Traveling—comes in the nature of a surprise to the American engineer. The applications of electricity to such purposes are already in wide use in workshops and buildings, and the rate of its introduction is rapidly accelerating. The patronizing impression has grown up among us that we are greatly in advance in these lines; the present work, however, will do much to remove the error, for it shows the practice to be in an advanced stage in Germany, and that its various details have been reduced to a solid engineering basis.

The author observes in the preface that the electrical operation of mining and pumping machinery, the auxiliary machinery of ships, and especially of hoisting transporting machinery, and the electrical driving of machinery in workshops, is rapidly advancing; and though such practice has suffered from many infantile disorders and mistakes, and has not yet reached full maturity, it is being rapidly perfected.

It has been the endeavor of the author to present in full detail the electrical elements of the class of machinery covered by the subject, to reduce these to working classifications, and to state the principles and formulas governing their application. The design of the machinery, of which the electrical apparatus forms an integral portion, is not treated at length, nor are the structural problems of cranes and elevators considered at length. This plan of the work, on the whole, is commendable.

The work is divided into two portions. The first, covering 255 pages, deals with the electrical elements of such machinery as the writer discusses. The mechanics of hoisting receives a brief discussion, and the adaptability of electricity for such purposes is reviewed; and the direct and alternating-current apparatus are compared and the principles are stated which should influence the choice in any case. One of the most important matters in the electrical operation of machinery for hoisting, is the violent fluctuations of the load. This must be met by careful attention to armature reaction, and the sparkless action at the brushes. The work goes into these details in a satisfactory manner with reference to the direct-current types of apparatus; but what is of especial interest to American engineers is the excellent discussion of these same details in polyphase machinery. The German engineer, being generally so well trained in the principles and physics of the alternating current, has been able to develop the applications of polyphase currents to a greater extent, generally, than has been done in this country.

About one-quarter of the book is devoted to controlling apparatus; and in this section, the author has been especially successful. It is accompanied by an extended analysis of the principles of regulators and rheostats of the especial types demanded by such service as hoisting and conveying. The conditions and relations for maximum efficiency are developed at length, and the discussion is elaborately illustrated by diagrams and curves. Though so much excellent literature abounds in the files of the ELECTRICAL WORLD and the transactions of the American Institute of Electrical Engineers, yet this work is an admirable supplement to it, especially on account of the treatment of the controlling apparatus for the alternating current.

The second portion of the work treats of the applications of electrical driving to elevators, cranes, hoists and transporting machinery. Nearly all the examples which form the basis of the discussion are taken from German practice, though some mention is made of the Sprague and other American systems. One is rather disappointed at not finding more extended notice of the notably excellent work in these lines which has been done in this country. Much of the treatment in this section is too profuse and merely descriptive. The illustrations are largely diagrammatical and without dimensions, and the discussions are too general for a guide to the designing engineer. The work would have been improved had fewer examples been considered, and these more adequately discussed and their dimensions fully stated.

A work of this character, to be of especial service to the engineer, should be accompanied by copious references to enable the reader to follow a topic of importance to him, to its literature. Practically no such references are given.

Directory of Electrical Societies, Etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Next meeting, Paris, Aug. 16, 1900.

CANADIAN ELECTRICAL ASSOCIATION. Next meeting, September, 1900. Place to be selected.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, Kansas City, Mo., Oct. 16, 17, 18 and 19, 1900.

NATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS. Next meeting, Pittsburg, Pa., Sept. 25, 26 and 27, 1900.

AMERICAN ELECTRO-THERAPEUTIC ASSOCIATION. Next meeting, New York, Sept. 25, 26 and 27, 1900.

THE ROENTGEN SOCIETY OF THE UNITED STATES. Next meeting, New York City, Dec. 13 and 14, 1900.

OHIO ELECTRIC LIGHT ASSOCIATION. Next meeting, Toledo, Ohio, Aug. 14-16, 1900.

OLD-TIME TELEGRAPHERS' ASSOCIATION AND THE U. S. MILITARY TELEGRAPH CORPS. Next meeting, Minneapolis, Minn., Sept. 18, 1900.

Sharp Dispute Over Chicago Board of Trade Quotations.

A sharp controversy between the Chicago Board of Trade and the Gold & Stock Telegraph Company, which is controlled by the Western Union Telegraph Company, over the terms of distributing the Board of Trade quotations, has reached a crisis, and President Thomas T. Eckert, of the Western Union, has issued the following statement, showing that the telegraph companies are prepared to stop sending out these quotations on Aug. 1 unless some other basis for an agreement is reached before that date:

"The Chicago Board of Trade some time ago submitted a proposition to the Western Union and Postal Telegraph Companies which demanded of the telegraph companies exorbitant financial terms, combined with impracticable conditions for the distribution of its market quotations. The telegraph companies have endeavored to meet the views of the Chicago Board of Trade in every way possible, having made a liberal counter proposition. The result is that the board has declined to accept the proposition of the telegraph companies, and has given notice that its market quotations will be withdrawn from the telegraph companies on Aug. 1 next.

"This action on the part of the Chicago Board of Trade will, after July 31, 1900, necessarily deprive our subscribers of the Chicago Board of Trade quotations, as they have heretofore been sent out. We therefore give this notice to our subscribers that they may govern themselves accordingly."

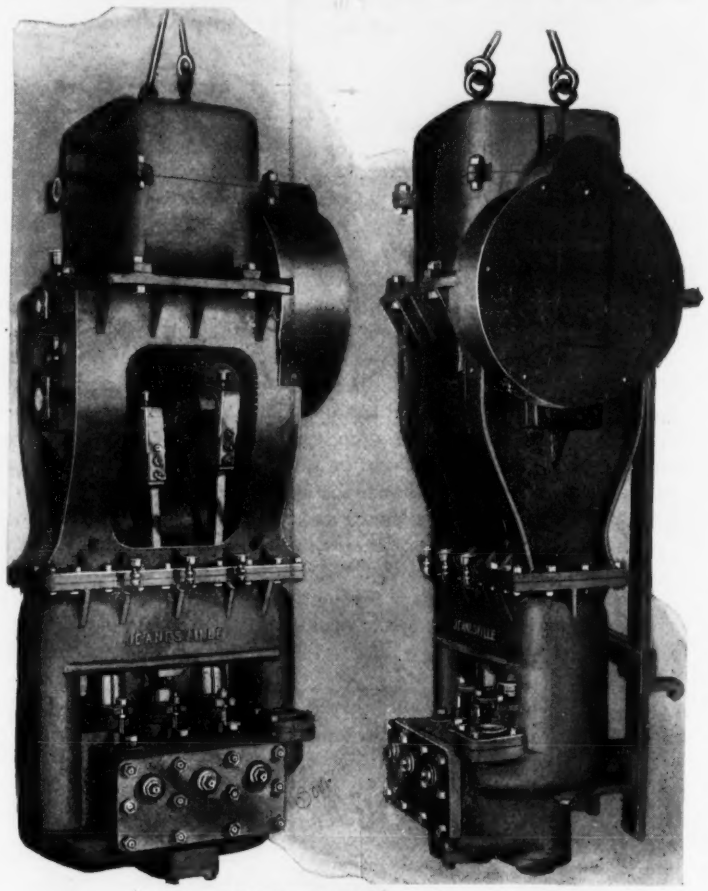
President Eckert has declined to say anything in regard to the controversy, in addition to this statement, as to what chances of an agreement may yet remain.

In this connection a special despatch from Chicago of June 19 says: The Type Telegraph Company, a new concern, is to pay the Board of Trade $2 per week for each ticker in use, and will supply the local field. The Board of Trade asks $100,000 a year from the telegraph companies for the market quotations. The latter bid $1,000 a month, and say it is all they can pay. They also announce that there is no money in distributing quotations at the price the boards asks, and they would rather give it up. There are 800 tickers in service here.

A Miner's Electric Sinking Pump.

There has been considerable demand for a miner's sinking pump that can be run by an electric motor, and we now illustrate a type brought out by the Jeanesville, Pa., Iron Works Company. The design embodies three single-acting plungers operated from common

crank shaft with crank pins placed 120 degs. apart. The resultant action of these three plungers is to produce a continuous and constant stream to the column pipe and reduce to a minimum the shock and jar thereon. The water cylinders are cast in one piece and are connected to the guides by hollow castings which form a vacuum chamber on one side and air chamber on the other. The valves are accessible through hand-holes at face of valve chamber. Each plunger is cast on end in hard, close-grained iron, and is bolted to a crosshead guide which is fitted with bronze adjustable shoes. Each connecting rod is fitted with bronze adjustable bearings at each end. The crank shaft is of best open-hearth steel and is driven by two gears fitted over the disks which form the outside cheeks of the two end cranks, thus relieving the shaft of at least one-half the strain that would be brought upon it if driven, as is usual, by a single gear at one end. It also economizes space, in that no extra room whatever is required for these gears; and what is equally, if not more important, it places them inside the main bearings. All the gearing is machine-cut and of such strength as to give a most liberal factor of safety on actual requirements. The crank shaft gearings are completely enclosed in a cast-iron frame. All parts are completely accessible for oils and inspection through a large hand plate. The motor is placed upon the top of the pump frame and connects the crank shaft by proper-designed gearing to give the desired speed to the pump. The pump frame is made to receive any make of motor which is adapted to this kind of work, and it may be either direct or alternating current.



ELECTRIC SINKING PUMP.

The machines are furnished complete, with all needed tools, etc. This pump is made in various sizes, the smallest having plungers 3½ ins. diameter and 8-in. stroke, and occupying, with the motor, a space 25 ins. by 31 ins. by 7 ft. The largest size has plungers 5½ ins. diameter by 8-in. stroke, and the size over all is 38 ins. by 39 ins. by 10 ft. The weights vary from 2500 to 3500 lbs., and the motors are made to suit any current, voltage, etc.

The English 1000-Mile Automobile Run.

The 15 judges who acted for the Automobile Club in connection with the recent Thousand Miles' Trial have, writes our English correspondent, issued their report and awards. It is a most painstaking report, 2500 calculations having been made, and marks allotted to various vehicles under 24 separate headings. Among these the most important are price, weight, power in proportion to weight, accessibility of mechanism, workmanship, condition of car at the end of the run, and regularity of running. Marked progress has been made, in the opinion of the judges, in the construction and general arrangement of auto-cars, and the judicious use of aluminum has added much to their efficiency and hill-climbing powers. The gold medal for the most meritorious vehicle, irrespective of class, has been awarded to the Hon. C. S. Rolls, for his 12-hp Panhard, who also received the silver cup for the best vehicle privately owned and operated. The following were the principal awards: Section 1 (vehicles entered by makers or agents).—Class A (vehicles selling at £200 or less): First, Benz Ideal. Class B (£200 to £300): First, Wolseley voiturette. Class C (£300 to £500): First prize to three Daimler Company's cars. Class D (over £500): No award. Class E (a) (motor-cycles carrying one person only): No award. Class E (b) (motor-cycles carrying two persons): First, Ariel quadricycle.

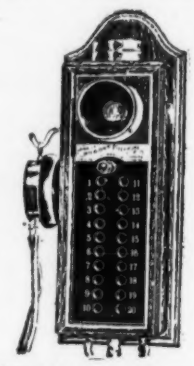
Secton 2 (privately-owned vehicles).—The gold medal for the most meritorious vehicle, irrespective of class, the owner having accompanied it throughout, and driven and steered at least half the distance, is awarded to the Hon. C. S. Rolls, in respect of his 12-hp Panhard car.

A number of silver and other medals were also awarded.

Intercommunicating Telephones.

The accompanying illustration represents a twenty-station intercommunicating telephone, which is one of the many styles of instruments manufactured by the Simplex Interior Telephone Company, 431 Main Street, Cincinnati, Ohio.

By the use of this system, connection may be had between any two telephones, and any number of pairs can hold conversation at the same time without interference with one another. This system obviates the necessity of a central exchange, and is operated from one central battery, no local battery being required. The instruments occupy very little space, being only 4½ ins. wide by 12 ins. long. As the cut shows, they are of neat design, and in their construction and finish the best of material and greatest care are used. The instrument is mounted in polished oak or walnut, with full nickel trimmings. The standard sizes are 5, 10, 14 and 20 stations, and instruments of 24 and 30 stations are made to order. This intercommunicating telephone is particularly designed for factories, stores, warehouses, public institutions, etc., where it is necessary to provide means of intercommunication between different floors and various parts of the building.



INTERCOMMUNICATING TELEPHONE.

The Simplex Company also manufactures telephones for short lines, such as from house to stable, or from one part of the house or store to another part. This instrument is of the same general design as the one above referred to, without the station connections. The Company manufactures, in addition, an instrument somewhat similar in appearance, designed for hotel use, for the purpose of intercommunication between office and rooms. The telephone switchboard manufactured by this company may be applied to any style of annunciator, and together with the instruments may be attached to push button wires. The Company also manufactures an emergency street railway telephone system, which is stated to be very flexible, and can be so arranged as to meet any and all conditions of street-railway work.

A Stand Pipe Searchlight at Marlboro, Mass.

During the recent Fourth of July celebrations at Marlboro, Mass., very effective use was made of a searchlight by placing it at the top of a stand pipe occupying the crest of a lofty hill. A picture of the special installation is herewith shown. The pipe stands on top of Sligo Hill, which is 600 ft. above sea level, and the pipe itself, used for fire purposes, towers up another 140 ft., so that the searchlight dominated the surrounding country from a height of about 750 ft. The scheme of using it was hit upon very shrewdly as an advertisement by the Marlboro Electric Company, whose station was, however, too far away to furnish the direct current needed. Under these

circumstances the steam end of the job was furnished by the city's road roller, which is shown in the engraving, and the current was obtained from a small Edison dynamo thus driven. It is possible a road roller has been called upon to play such a part before, but no records exist to that effect. The fence seen in the picture is that of the reservoir supplying the city, being 390 feet above Main Street.

The projector thus used was obtained from Mr. C. J. Bogue, 209 Centre Street, N. Y., and is his 16-in., English naval type, taking 50 amperes. It was used in all four nights during the period over which a special celebration was going on in the city. On the night of July 3 it ran from 8:30 p. m. until 3 a. m., and on the other three nights from 8:30 till 11 p. m., and it naturally attracted considerable attention, not only in the "Highland City' itself, but throughout the adjoining country for many miles in every direction. We are indebted for details to Mr. Frank O. Barnes, the superintendent of the Marlboro Electric Company, who carried out the idea, and who says: "The searchlight has been a great advertising card for us." He and Mr. Bogue are to be congratulated on the scheme and on the effect thus produced.

SEARCHLIGHT ON STANDPIPE.

Cooking Utensils for Electrical Heaters.

The accompanying cut gives illustrations of some new utensils for use with electrical stoves, which are being put upon the market by the Simplex Electrical Company (heating department), Cambridgeport, Mass.

In order to obtain the best results with electric stoves, utensils of proper size and form, and arranged to make intimate contact with the heater should be used. The articles illustrated are made to lock firmly to the heater when in place and are instantly removable. When locked in place the heat is transmitted to the work far more readily than is possible with any vessel sitting loosely on the stove. Each of the vessels is properly proportioned for its proper stove, and accidental spilling of the contents cannot occur when food is cooking.

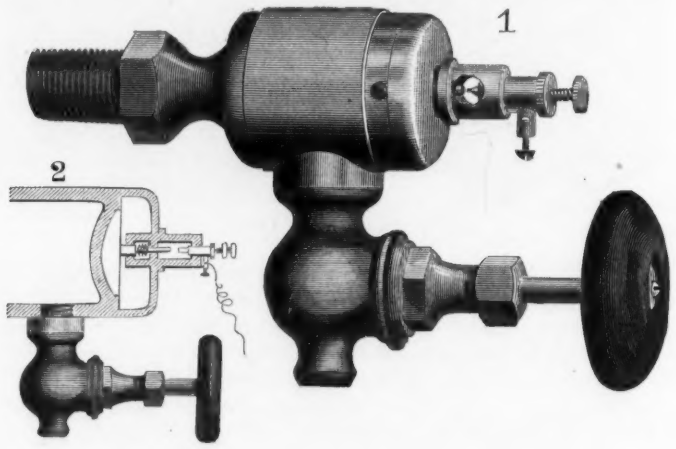
These goods are made in the most substantial manner of heavy copper, nickel plated and provided with rosewood handles. While they are patented, the company will gladly give any of its customers the right to make similar ones for use in connection with the Simplex Company's heaters, but only where the regular shapes and sizes do not meet the requirements.

ELECTRIC COOKING UTENSILS.

The Mathews Alarm Try-Cock.

The try-cock herewith illustrated is intended for use on all boilers to guard against low water. The action of the cock when the water gets below a safe level being merely to close an electrical contact, the alarm may be given in as many places as desired. It is easy to attach to the boiler, as it replaces the lower try-cock, and generally can be screwed into the same hole without retapping; and under ordinary conditions it is used in the same manner as the one removed.

The general appearance of the device is showr in the first figure. Through the hole in the case at the right may be seen the two points which make the electrical contact, and which are better illustrated in the detail sketch (Fig. 2). As long as the German silver diaphragm, to which the inside contact point is attached, remains in the position shown, the circuit is open; but if the air in the chamber of which the diaphragm forms one side expands sufficiently to cause the diaphragm to spring out, the contact points are brought together and the alarm is given. This will occur when the large chamber of the cock is filled with steam instead of water, the increase in temperature causing a sufficient expansion of the air to operate the device. In order that a positive contact may be produced, the diaphragm is fixed in place



LOW-WATER ALARM TRY-COCK.

under a slight compression, so that when the pressure against it becomes great enough it is forced out with a snap. The screw in the side of the smaller chamber enables the point at which this occurs to be accurately adjusted. The distance between the contact points is adjusted by the screw and set-nut on the right.

The apparatus is well made and finished. The electrical parts are designed in such a manner as to avoid failures in the action of contacts, etc., and the operation of the try-cock under ordinary conditions is as simple as that of those in general use. It is being put on the market by the Electric Boiler Protection Company, of 39 Cortlandt Street, New York.

The De Dion-Bouton Motorettes.

Over in Europe, and particularly in France, one sees everywhere the automobiles of the De Dion-Bouton type, with which excellent results have been attained. The motors of this make are also in use by other automobile manufacturers, with the result that over 20,000 of them are already in use. The rights for this country have now been secured by the De Dion-Bouton Motorette Company, of Brooklyn, N. Y., who are the sole agents and licensed manufacturers in the United States. The officers of the company are: F. C. Cocheu, president; C. J. Field, vice-president and general manager; A. A. Halsey, secretary and treasurer, and J. C. Church, counsel.

DE DION-BOUTON MOTORETTE.

The De Dion-Bouton motors are of the hydrocarbon type, using gasolene. The 2¾-hp, air-cooled motor of the De Dion make, which is especially adapted and recommended for motorcycles, tricycles and quadricycles, weighs complete less than 60 lbs. The other two types of motor are specially adapted for light motorettes, and are, respectively, one with an air-cooled cylinder and water-jacketed head of about 3-hp capacity, and one with water-jacketed cylinder, of 3½-hp capacity, weight about 95 lbs. These latter are the types which are used to operate the "motorette," which appears in the illustration shown. This motorette has a comfortable seating capacity for three persons, weighs less than 700 lbs., and will operate over any normal roads, and up any hill where horse-drawn vehicles can go, carrying its full load. The motorette is geared and arranged to operate at a speed of from 5 to 25 miles per hour.

The De Dion-Bouton Motorette Company has secured large buildings at Church Lane and Thirty-seventh Street, Brooklyn, within 30 minutes of the Battery or of the Brooklyn Bridge, for its general offices and factory location, with plenty of good roads all around to give a practical demonstration of the operation of its motorcycles and motorettes.

Mr. Field returned from Paris recently after a month's visit, and has brought back with him everything necessary for the successful organization of the business here, including a large stock of sample motors and motorettes, and all the necessary parts, etc., for getting out their first stock of motorettes.

Improved Lippincott Planimeter.

In Fig. 1 a novel form of a planimeter is illustrated, which is claimed to be remarkably accurate and convenient. The instrument is the invention of Mr. A. C. Lippincott, Taylor Building, New York City. The wheel and shaft are of one piece, and in tracing a figure, such as an indicator diagram, the wheel and shaft move endwise. The shaft travels under roller bearings at either end, and to one extremity the index is directly attached. This index carries a "cross-hair," a common feature employed in instruments where a close reading is required. The scales, six in number, correspond with the scales most commonly employed in indicator work, or are convenient multiples of them. For instance, from the 40-scale, the reading for a 5, 10, 20, 40 and 80-spring, may be obtained readily. In this manner from the six scales included, a direct reading may be obtained for 25 scales. The accuracy of the Lippincott planimeter has been proven in the mathematical demonstration made by Mr. Townsend Wolcott, copies of which may be obtained from the inventor.

By a judicious distribution of the weight on opposite sides of the frame-block, a perfect balance is obtained, which admits of the measurements of shorter diagrams, with which it was often necessary to set the tracer bar to twice the length of the diagram, and trace twice to obtain a correct reading.

The pivot bar is jointed, as shown, making the instrument very compact, when in its case (Fig. 2), which is of morocco, velvet-lined. The planimeter is made of composition and aluminum, highly polished and nickeled.

To use the instrument, no adjustment of scales is required. On placing the indicator card about in the position shown in Fig. 1, with the tracer point at the lower extremity of either diagram, by moving the fixed point to the right or left, the "cross-wire" may be brought to zero on all the scales, after which the fixed point is pressed into the drawing-board. Tracing the card in the direction taken by the hands of a watch, and returning to the starting point, the cross-wire will be found to accurately indicate the mean effective pressure for any spring. The instrument may be set to read areas in square inches. If required, special scales will be provided to read horse-power direct. The 40 and 50 scales are provided with verniers. Catalogue and further particulars may be had by addressing the inventor.

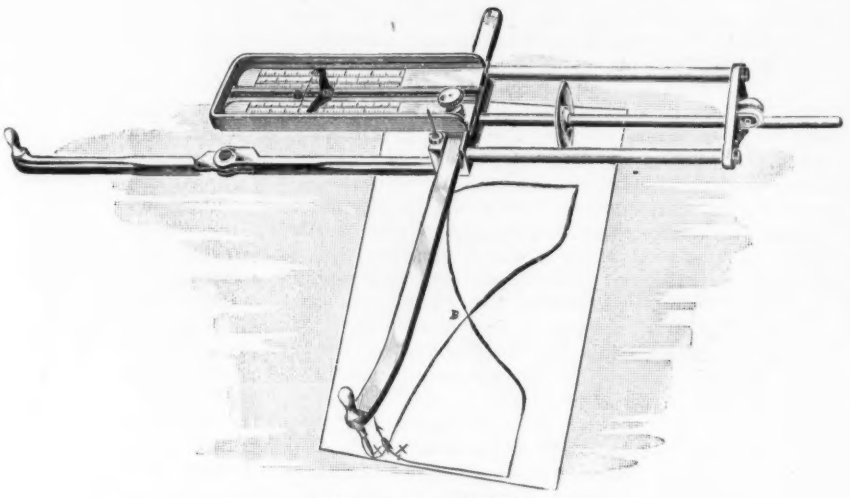


FIG. 1.—PLANIMETER.

FIG. 2.—PLANIMETER.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET.—Summer listlessness seems to have possession of the stock market, the business of last week being quite as commonplace and featureless as that of the several weeks past. Speculation continues to be dull, and trading was largely of a professional character. The New York market does not appear to be susceptible to outside influences, such as the disturbed condition of foreign markets on Chinese news, higher exchange and the export of $2,000,000 gold—all these failed to depress it. In the money market, there was a better inquiry for time loans, the quotations being 3 to 3¾ per cent for short and 4 to 4½ per cent for four and six months' loans on mixed collateral, while 5 per cent is asked on industrial securities. Call money is between 1¼ to 1¾ per cent. Mercantile paper is quoted at 4 to 4½ per cent for double names, the rate being firmer. Electric stocks partake of the general inactivity in stock trading, and prices coursed through the week with no great fluctuations. The leading electric railway shares, however, closed the week with substantial gains, as indicated below. General Electric's closing quotation was 130 ½, a net loss of ⅜ point as compared with last week's closing price. Western Union closed at 79⅞, a net gain of ⅛; Brooklyn Rapid Transit closed at 56½, being a net advance of 3¼. The sales for the week aggregated 142,350 shares. Metropolitan Street Railway closed with a net gain of 3¼, the final quotation being 154¼. The market for outside securities was duller than it has been for a long time past. For several days there was practically no business transacted at all. Prices, however, held quite firm, and in some instances quotations showed considerable advances. Electric Vehicle, together with several of its subsidiary issues, showed some strength and advanced substantially. It sold up to 24, and closed at 23 bid, a net gain of 4 points. The advance in these stocks was not attributable to any news in regard to them, and the gains recorded seemed in large measure due to manipulative purchases. In the miscellaneous list, the following closing prices are quoted: Electric Boat, 16; do. pfd., 30; Elec. Vehicle, 23; do. pfd., 40; Gen. Carriage, 6⅜; Ill. Elec. Veh. Trans., 1⅜; New Eng. Elec. Trans, 4½; N. Y. Elec. Veh. Trans., 8¾; Telep., Tel. & Cable of America, 5; N. Y. & N. J. Telephone, 160; Hudson River Tel. 116. In Boston closing quotations were: American Telephone, 145; Erie Telephone, 96; New England Tel., 122; Mexican Tel., 2. In Philadelphia, Elec. Stor. Bat., com., closed at 75; do. pfd., 80; Gen. Elec. Automobile, ¼; Elec. Co. of America, 9½.

NATIONAL TELEPHONE.—The Philadelphia stock exchange asserts that the public will be considerably surprised when the full board of directors and officers of the National Telephone & Telegraph Company is announced. The list will include, it is alleged, active men and capitalists interested in the following companies: American Bell Telephone Company and several of the subsidiary companies, the Western Union and Postal Telegraph companies, the Commercial Cable and the Telephone, Telegraph & Cable Company of America. The incorporation capital of $50,000,000 is merely a foundation for one of the largest corporations in the world. Before the close of the year the initiatory capital will be fully employed in the business for which the corporation has been organized, more particularly that of electrical communication and manufacturing incident thereto.

DIVIDENDS.—The Edison Electric Illuminating Company, New York, has declared a quarterly dividend of 2 per cent, payable Aug. 10. The American Bell Telephone Company has declared a dividend of 2 per cent, payable July 28. The Wagner Electric Manufacturing Company, St. Louis, has declared a quarterly dividend of 2 per cent. The Bell Telephone Company, of Philadelphia, has declared the regular quarterly dividend of 2 per cent, payable July 28. The Minneapolis General Electric Company has declared its regular semi-annual dividend of 3 per cent on the preferred stock, payable Aug. 1. Chesapeake & Potomac Telephone Company, Washington, has declared a dividend of $1 per share, payable July 23. The Chicago Edison Company has declared a quarterly dividend of 2 per cent.

N. Y. METROPOLITAN.—Insiders are again talking very bullishly on Metropolitan Street Railway, says the *Wall Street Journal*, and are predicting that it will see the old high prices again before very long. Their arguments seem to be based largely upon earnings, which continue to show good increases, and upon the good results to follow still further saving in expenses. Metropolitan is expected to show a good surplus over dividends this year, and the management expects a large growth in gross earnings this fall. The Third Avenue problem, moreover, on further study, is believed to present better possibilities than were thought at first to exist.

MASSACHUSETTS ELECTRIC COMPANIES.—A special meeting of the Massachusetts Electric Companies, July 30, is called for the purpose of confirming the purchase of the South Shore & Boston Street Railway Company, and securing authority to issue new stock on the basis of one share of preferred and three-quarter share of common stock for each share of South Shore & Boston stock. There are 6900 shares of this stock calling for the issuance of $690,000 Massachusetts Electric Companies' preferred stock and $517,500 common stock.

INCREASE OF GENERAL ELECTRIC STOCK.—A special meeting of the stockholders of the General Electric Company was held at Schenectady, N. Y., July 17, when it was voted to increase the capital stock of the company from $20,827,200 to $25,242,200. The $4,415,000 new stock will be used to pay for and redeem outstanding 30-year, 5 per cent, gold debenture bonds, issued in June, 1892.

NEW YORK TELEPHONE.—A special meeting of the stockholders of the New York Telephone Company will be held on Aug 8, at 15 Dey Street, for the purpose of voting upon a proposition to increase the company's capital stock from $16,000,000 to $30,000,000.

Commercial Intelligence.

THE WEEK IN TRADE.—The reports received by the commercial agencies concerning the state of trade throughout the country indicate a somewhat better feeling. In summarizing its reports Bradstreet's says improved crop conditions furnish the keynote of the trade and price movement. The beginning of fall trade is more clearly visible at the West, Northwest and South, while at the East the markets are slower to experience the improvement, and are, consequently, seasonably dull. Bank clearings as yet fail to reflect any perceptible improvement in distribution, and railway earnings, though of large volume, are showing less notable increases both in gross and net returns than they did last year. If reports from leading centres of cost of raw material and labor in the iron and steel trade are reliable, they are taken to indicate that the prices of these manufactures have about reached the bottom notch. A favorable feature in the situation is the increasing number of inquiries from Europe. Soft coal is going abroad, too, and copper is firmer. For five months the gross receipts of 120 railroads gained 14.8 per cent and net receipts 17.8 per cent. For the second week of July gross receipts of 50 roads will aggregate $6,444,187, a gain of 6.5 per cent over a year ago. The business failures during the week, according to Bradstreet's compilation, number 202, against 221 the previous week, 174 the same week a year ago, 188 in 1898, 220 in 1897 and 280 in 1896. Trading in copper assumed some prominence last week. The greater demand for copper from abroad was viewed as a very favorable indication, and the price of copper securities was reported as very firm. Amalgamated Copper sold as high at 88 and closed at 87½ bid, a net gain of 2¾ points. Tennessee Copper, Union Copper and British Columbia Copper also advanced. Following the advance in price in London, the New York market was pushed off a shade. Lake Copper is quoted at 16⅜@16½c.; Electrolytic, 16⅛@16⅜c.; Casting, 16⅛@16⅜c.

EXPORTS OF ELECTRICAL MATERIAL.—The following were the exports of electrical material from the port of New York for the week ending July 17: Argentine Republic—15 cases electrical machinery, $1,624; 2 cases electrical material, $33. Antwerp—30 boxes motors, $5,302; 49 packages electrical material, $12,388. Athens—29 packages electrical material, $797. British East Indies—45 packages electrical material, $4,349; 6 cases electrical machinery, $987. Brussels—5 packages electrical material, $116. British possessions in Africa—145 packages electrical machinery, $10,506; 3 packages electrical machinery, $85. Brazil—41 cases electrical machinery, $3,334; 18 cases electrical goods, $371. British Guiana—1 case electrical material, $30. British West Indies—8 packages electrical material, $349. Bristol—169 cases electrical machinery, $30,536. Central America—69 cases electrical material, $739. Copenhagen—2 boxes electrical material, $330. China—5 cases electrical material, $597. Cuba—29 packages electrical material, $1,148. Dublin—51 packages electrical material, $3,800. Ecuador—91 cases electrical machinery, $16,370. Glasgow—84 packages electric motors, $7,762; 3 cases electrical material, $200; 140 reels electric cable, $49,205. Genoa—3 packages electrical material, $163. Hayti—6 packages electrical material, $107. Havre—16 cases electrical machinery, $421; 40 cases electrical material, $10,861. Hamburg—10 packages electrical machinery, $2,454; 40 packages electrical material, $4,212; 2 packages electric motors, $85. Hull—3 cases electrical material, $196. Japan—139 packages electrical material, $9,567; 94 cases electric machinery, $4,764. Liverpool—142 packages electrical material, $16,707; 43 packages motors, $2,040; 460 trolley poles, $16,587. London—8 packages electrical machinery, $693; 212 cases electrical material, $12,714; 23 packages automobiles, $24,750; 21 cases motors, $1,470. Mexico—158 packages electrical material, $13,786; 12 pack-

ages electric machinery, $5,552. Naples—39 cases electrical material, $9,289; 93 packages motors, $2,162. Oporto—5 packages electrical material, $199. Plymouth—140 trolley poles, $5,143; 110 cases electrical material, $302. Puerto Rico—95 packages electrical machinery, $2,660; 1 case electrical material, $23. Riga—4 cases electrical material, $508. Southampton—13 packages electrical material, $1,274; 206 packages electric machinery, $3,553. Sandwich Islands—34 packages electrical material, $97. St. Gall—5 cases electrical material, $400. San Domingo—2 electrical machines, $23. St. Petersburg—43 cases electric motors, $6,992; 4 cases electrical material, $133. U. S. Columbia—26 packages electrical material, $1,246.

PURCHASES FOR AUSTRALIA.—Important purchases of power-house equipment, made necessary by the pending conversion of the steam and cable tramways in Sydney and vicinity into an electric system, will be made this week. As already reported in the ELECTRICAL WORLD AND ENGINEER, Charles Oliver, the chief railway commissioner of the New South Wales Government Railways and Tramways, is now in New York. In course of conversation on Tuesday Mr. Oliver said: "The Sydney City & Suburban Tramways at present have a power house which is equipped with four 850-kw generators built by the General Electric Company. At the time the conversion was decided upon it was calculated that by doubling the capacity we would be in a position to generate more than sufficient energy to operate all our system, which is 70 miles in length. It has now been found, however, that because of our great increase of traffic it will be necessary to install three 1500-kw generators. At present we make use of horizontal engines manufactured by the Edward P. Allis Company, of Milwaukee, but we shall now order vertical ones. The generators and engines, together with the boilers, piping and all accessories, will show an aggregate value in the neighborhood of $850,000, and I expect any moment a confirmatory cable from New South Wales, receipt of which will enable me to close the contracts." Continuing, Mr. Oliver said: "Before the new system is in operation we expect that fully $3,500,000 will be expended. Everything in the way of material and equipment will be bought in the United States, except the car bodies, which we build ourselves. Our wood is cheap, and we do not attempt the elaborate decoration which American car builders espouse. The principal contracts, outside those for the generating station, will be for trolley poles and wiring, and as it will be fully two and a half years before the new system is an accomplished fact, American manufacturers may calculate on substantial orders right along. At present we have about 25 miles of electric road in operation." In talking about the working of the tramways, Mr. Oliver stated that the lines were divided into 2-cent sections. The longest section so far was 1¾ miles, and as the system being operated by the government is only expected to earn 5 per cent when any particular section showed a larger net gain than that percentage, the distance is immediately lengthened.

THE MILLER-KNOBLOCK COMPANY, South Bend, Ind., manufacturers of commutators and armature coils, has consolidated with the Northwestern Electric Manufacturing Company, of Chicago, makers of magnet wire, electromagnets and spark coils, and the combined business will be conducted under the name of the Miller-Knoblock Electric Manufacturing Company, at South Bend, Ind. The machinery composing the covering plant of the Northwestern Company has been moved to South Bend and set up, and is now in operation. The new concern will immediately build additional insulating machines, and while the plant they are now operating produces silk and cotton-covered magnet wire from No. 18 to No. 40, the new machines will increase the line from No. 0 to No. 40. With increased capitalization, the company contemplates large improvements, not only in the commutator and armature coil business, but in the magnet wire business. As the plant occupied is large and well adapted to the work, the product should be equal to any on the market, and as South Bend is an ideal point for manufacturing and selling, there is every prospect that the company's business will continue to increase. The company will make a specialty of fine covered wire and coils for telephones.

THE TOTAL FOREIGN COMMERCE of the United States during the fiscal year 1900 exceeds by 16⅔ per cent that of any preceding year, being 320 million dollars greater than that of 1899, the heaviest one on record preceding the one which has just ended. The total commerce of the year, as shown by the figures of the Treasury Bureau of Statistics, is $2,244,193,543. The exports are $1,394,479,214, or 163 million dollars in excess of those of 1898, which held the record of the largest exports until the record of 1900 was made. All of the great classes show an increase in exportation, manufactures being nearly 100 million dollars over the phenomenal year 1899. Imports are also heavy, especially in the class designated as "articles in a crude condition which enter into the various processes of domestic industry." Of the five great classes of imports, articles in a crude condition for use in manufacturing show by far the largest growth. Manufactures show a gain of about 20 million dollars over last year; articles of voluntary use, luxuries, etc., also about 20 million; articles wholly or partially manufactured for use in manufacturing, 25 million, and articles in a crude condition, which enter into the various processes of domestic industry, over 75 million dollars.

THE CUYAHOGA TELEPHONE COMPANY, Cleveland, Ohio, has decided on improvements which will greatly increase its capacity. The present exchange will be increased to twice its size and three branch exchanges will be erected to take care of suburban subscribers—one will be in East Cleveland, another at Rocky River, and a third at Nottingham. When the improvements are completed the system will be able to handle 20,000 individual subscribers, which, it is claimed, will make it the largest independent exchange in the country. This increase of capacity is additional to that which is now being installed by the Kellogg Switchboard & Construction Company, and which will give about 9000 connections. The same company is building the additional boards, as well as the branch exchanges mentioned. In view of the contemplated improvements, the directors of the Cuyahoga Company have decided to increase the capital stock of the company from $3,000,000 to $4,000,000.

H. STEINMANN, consulting architect, of 29 Broadway, New York City, has secured a contract from the United Breweries Company, Limited, of London, for the purchasing of material, equipment, etc., required for a $500,000 ale and lager beer brewery, which is about to be erected at Cape Town, South Africa. The brewery will be lit by electric light, and part of the machinery will be driven by electricity. The Sapporo Brewing Company, of Sapporo, Hokkaido, Japan, has decided to erect a $300,000 brewery in Tokio, which will be the first establishment of its kind in that city. One of the features of the plant will be that it is to be driven entirely by electricity. Mr. Steinmann will have the letting of the contracts on the arrival of the superintending architect of the Japanese Company, who is expected here in August.

MR. H. C. REAGAN, JR., electrical engineer, Easton, Pa., has just installed a 160-light incandescent plant at Island Park, that city, using also 110-volt arc lights on the system. This is operated by a series motor, taking current from a 550-volt circuit. To prevent the motor from speeding up when a fuse should blow on either the arc or the incandescent circuit, a magnetic switch makes circuit with a water rheostat which holds the load normal until the fuse is renewed. A portion of the current from the dynamo is used to operate a biograph machine in the afternoon and evening, and 'tween whiles to haul up the boats from the water on to the Niagara chutes.

THE MORRIS ELECTRIC COMPANY, 15 Cortlandt Street, New York, has lately shipped a large consignment of track construction tools to Lisbon, Portugal. The shipment includes small forges, picks, bars, etc., 4000 rail bonds, and a Conant rail joint testing instrument. This company has also filled large orders for street railway supplies in the City of Mexico. Among the most recent has been one for 300 cast iron car wheels from the Lehigh Car Wheel and Axle Works, and one for 50 electric headlights made by the Crouse-Hinds Electric Company.

THE BARR PUMPING ENGINE COMPANY, of Germantown Junction, Philadelphia, has recently closed a contract with the city of Haverhill, Mass., for a 6,000,000-gallon, horizontal, cross-compound, condensing crank and flywheel pumping engine. This engine is to be in all respects similar to one that has been installed by this company for the city of Waltham, Mass., and which on test gave one of the highest duties that has ever been recorded for compound pumping engines.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY, Cincinnati, Ohio, has installed generators ranging from 250 kilowatts to 900 kilowatts in the plants of the American Sugar Refining Company, Brooklyn, N. Y.; the big plate glass factory at Ottawa, Ill., and the Stanley Electric Company, Pittsfield, Mass. The orders aggregated $70,000.

CENTURY TELEPHONE CONSTRUCTION COMPANY.—Cleveland, Ohio, reports the sale of the entire apparatus and material for a 100-number exchange in Kentucky, and apparatus for an exchange of equal size in Tennessee. The company reports also an unexpectedly large demand for its new Century transmitter.

STREET CARS FOR HONOLULU.—Messrs. C. Roehr & Sons, Bucyrus, Ohio, manufacturers of the Duplex street railway cars, last week shipped eight cars to the Honolulu Rapid Transit Street Railway Company, Honolulu, Hawaii. This is the first shipment of an order for 30 cars.

THE POTOMAC TERRA COTTA CONDUIT COMPANY, of Washington, D. C., has just shipped over 100 tons of two-duct conduit to the Havana Electric Railway Company, Limited,. The order was secured through the Morris Electric Company, of New York City.

THE MANHATTAN HOTEL, New York City, in its new addition, will install 800-hp of Westinghouse direct-connected engines and generators. The plant will be similar to the one now running in the old section, the units being 200-hp each.

THE CINCINNATI EDISON ELECTRIC COMPANY has placed an order with the Bullock Electric Manufacturing Company, of the same city, for two motor-generator sets, each set to consist of two 60-kw generators driven by a 160-hp motor.

Special Correspondence.

ENGLISH NOTES.

London Office ELECTRICAL WORLD AND ENGINEER,
July 9, 1900.

THE DUBLIN CORPORATION has had a narrow escape from having a direct competitor in electric lighting, the Dublin electrical bill having been thrown out of Parliament on the third reading by a narrow majority of six. Some time ago the bill was passed through committee, and it looked very much as if Dublin would at last get an electric-light supply which would be adequate. The corporation of Dublin has certainly neglected most shamefully its opportunities, and at the last moment has been given another chance to show what it can do when stimulated by threatened competition. Had the bill gone through, Dublin would have been the first city where permission was granted to install an electric light plant in direct competition with an existing municipal plant.

THE JOHNSON-LUNDELL ELECTRIC TRACTION COMPANY, LIMITED, is gradually getting into good shape for doing business, and has recently engaged Mr. Arthur Tilley as secretary and Mr. A. F. Hall as engineer. The latter has had extensive experience in the United States, and was at one time draughtsman with Mr. H. F. Parshall, when the latter was engaged in generator-designing for the General Electric Company at Schenectady. Mr. Hall has gone to New York to confer with Mr. Lundell upon the details of the company's special inventions. We understand that Mr. Lundell has recently been engaged in perfecting the designs of the tramway car motor and controller, and he reports also that the quality of his differential pull piece will appear more fully in the largest size of the railway generators.

General News.

THE TELEPHONE.

CLARKESVILLE, GA.—The Standard Telephone Company has applied for a charter to construct a telephone system.

GLENN SPRINGS, S. C.—The Glenn Springs Telephone Company has been chartered, with a capital of $500. A. O. Simpson is president.

PORTAGE, WIS.—During a recent electrical storm the cable house of the Portage Telephone Company was struck by lightning and burned.

KNOXVILLE, TENN.—It is reported that the Knoxville Telephone Company has under consideration several extensions to its lines in the suburbs.

CHARLESTON, S. C.—The Bell Telephone Company proposes to place its wires underground in this city. A new, up-to-date exchange is being established.

FINDLAY, OHIO.—The Findlay Home Telephone Company has succeeded after a hard fight with the Bell Company in securing a franchise from the City Council.

RICHMOND, IND.—The Home Telephone Company, of Richmond, has placed a mortgage of $175,000 on its plant, the money to be used in extensive equipments.

SPRINGFIELD, ILL.—The Kinloch Long Distance Telephone Company, of Missouri, capital $300,000, is licensed to do business in Illinois, with a State capital of $75,000.

TRENTON, N. J.—The Automatic Telephone Meter Company, of East Orange, has been incorporated. Capital, $125,000. Incorporators: C. Bate, W. Fairchild, E. J. McNulty.

GENEVA, IND.—The Geneva Telephone Company has been incorporated. Capital, $5,000. Incorporators: H. M. Aspy, A. J. Miller, A. G. Briggs, T. Drew, O. O. Juday, all of Geneva.

ERIN, TEX.—The Houston County Telephone Company has been chartered, with a capital stock of $2,500. The incorporators are: J. M. Gooley, J. W. Broaden, W. R. Boone and others.

CUERO, TEX.—The Cuero & Sasseville Telephone Company has been incorporated. Capital, $6,000. Incorporators: Mrs. Jane Hunter, Mrs. Willie Breeden, Mrs. S. D. Weldon, all of Cuero.

CINCINNATI, OHIO.—The new common battery system recently introduced in the branch exchanges in Cincinnati is now complete. Central or Main exchange was cut in Saturday, July 21.

HAGERSTOWN, IND.—The Hagerstown Telephone Company has been incorporated. Capital, $8,000. Incorporators: J. Bowman, B. G. Jewett, J. M. Hartley, L. M. Pierce, all of Hagerstown.

CORNELIA, GA.—The Cleveland & Cornelia Telephone Company has been incorporated by J. J. Kinsey, Cleveland, president; Dr. D. A. York, Cornelia, vice-president; J. T. King, Cornelia, treasurer.

HARTFORD CITY, IND.—The Indiana Telephone Company, of Hartford City, has been incorporated. Capital, $50,000. Incorporators: W. B. Cooley, A. G. Lufton, H. D. Miller, all of Hartford City.

BALTIMORE, MD.—The new switchboard of the Maryland Telephone & Telegraph Company is now being installed in the company's building at the northeast corner of Courtland and Lexington streets.

AUSTIN, TEX.—The Texas Gulf Telephone Company, of Nacogdoches, has been incorporated. Capital, $10,000. Incorporators: E. C. Branch, George H. Davidson, K. K. Branch, W. S. Beeson, all of Nacogdoches.

RICHMOND, VA.—The Long Distance Telephone Company, of Virginia, has commenced building connecting lines at seven different points in the State. It is the purpose to unite all the independent companies in this State.

HUBBARD, OHIO.—R. S. Lewis, representing the Central District Printing & Telegraph Company of Pittsburg, is at work securing subscribers for an independent exchange here. A franchise will be asked for in the near future.

NASHVILLE, TENN.—A charter has been granted the Loudon & Paint Rock Telephone Company, of Loudon County. Capital stock, $500. The incorporators are: R. H. Bell, J. G. Greer, J. D. Taliaferro, John Simpson and W. S. Williams.

BEMIDJI, MINN.—The Bemidji Telephone Exchange Company has been incorporated. Capital, $10,000. Incorporators: J. H. Haner, of Bemidji; A. D. Stephens, De Forest Bucklen, both of Crookston; M. McKinnon, A. Kaiser, both of Fosston.

CHARLESTON, W. VA.—The Farmers' Telephone Company, of Van Voorhis, has been incorporated. Capital, $100,000. Incorporators: E. Moore, A. J. Graham, M. Van Voorhis, N. J. Mapel, L. D. John, all of Van Voorhis; J. Mooreland, attorney, Morgantown.

PITTSBURG, PA.—The West Pennsylvania Long Distance Telephone Company, of Pittsburg, has been incorporated. Capital, $10,000. Incorporators: H. A. Parr, S. N. Browne, both of Baltimore, Md.; W. D. Evans, R. A. Spring, W. W. Handy, all of Pittsburg.

MAMARONECK, N. Y.—The New York Telephone Company is applying to village authorities throughout the county for permission to put wires underground and work has already begun on changing the wires from poles to subways in the western part of the county.

MILWAUKEE, WIS.—The Wisconsin Telephone Company reports a net gain of 497 subscribers on June 30. The Erie Telephone system, which includes this company, reports a net gain of 2744 subscribers in June, making a total number of 126,455 subscribers of this system on June 30.

KOKOMO, IND.—Work on the new independent telephone plant here, to cost $40,000, is progressing rapidly. An exchange is being fitted up with all the modern equipments, to cost $10,000. W. N. Turner, principal owner, announces that they will be ready for business by Sept. 1, with an excess of 400 subscribers.

ANDERSON, IND.—The Anderson Telephone Company, a new independent concern, at a meeting elected the following directors: George W. Beers and Samuel Foster, of Fort Wayne; George Quick, B. W. Scott, H. C. Brown and William Boland, of Anderson. George W. Beers was elected president. The plant will be ready for business Jan. 1.

MUNCIE, IND.—The Selma-Town Hill Telephone Company has been organized in this county by farmers living east of the city, who are constructing a telephone system to supply the stockholders. The company will have connections with the Bell plant, doing business in this city, and will supply a large number of farmers with service with one another and with Muncie.

MT. VERNON, ILL.—Walter Watson and Albert Watson, of Mt. Vernon, Ill., have purchased the interest of Monmouth College, and B. G. Kimmel, of Effingham, Ill., in the Southern Illinois Telephone Company. The company has been reorganized, with Albert Watson, president; O. M. Waters, treasurer, and A. R. Wilson, of Monmouth, as secretary and general manager.

MARTIN, TENN.—At a recent meeting of the stockholders of the Weakley County Telephone Company, George E. Bowden was re-elected president; Dr. D. W. Scates, vice-president; J. H. Wilson, treasurer, and Rev. W. Martin, secretary, with the following named as directors: T. M. Ryan, T. J. Jeter, J. E. Kennedy, R. W. Martin, G. W. Hall, J. L. Smith, T. H. Farmer, C. W. Cottrell and Ted Little.

VINTON, IA.—The Benton County Telephone & Telegraph Company, of Vinton, has been incorporated, with a capital of $25,000. The incorporators are Frank G. Ray, S. S. Lichty, G. H. Gilchrist, A. S. Chadbourne, W. P. Whipple, H. J. Nietert, P. G. Henderson and J. H. Davis. This company has bought up the property of the Bishop Telephone Company, which had a line from La Porte to Brandon.

THE PENNSYLVANIA RAILROAD COMPANY and the Pennsylvania Company are contemplating the establishment of their own telephone system along the main lines of their railroad lines. The Pennsylvania Railroad is now stringing additional wires between Pittsburg and Altoona. When the system is completed a great deal of work which is now done by telegraph will then be transacted by telephone.

MILWAUKEE, WIS.—The Wisconsin Telephone Company on July 1 extended minute service to all points in Southern Wisconsin. The new rates affect business from Milwaukee to Racine, Kenosha, Burlington, Janesville, Beloit, Lake Geneva, Whitewater, Jefferson, Fort Atkinson, Stoughton, Monroe, Darlington, Plateville, Mineral Point and all intermediate points. Minute rates have not been quoted to points less than 30 miles distant, but in nearly all cases the three-minute rates have been reduced, as the new rates are figured on an air-line basis.

ERIE TELEPHONE made a net gain of 19,891 subscribers for the six months ending June 30, 1900, making a total number connected of 126,455. The net gain and total number connected are distributed as follows: Southwestern Company, net gain, 5683; total connected, 34,469. Cleveland Company, net gain, 1335; total connected, 15,011. Northwestern Company, net gain, 3319; total connected, 19,496. Michigan Company, net gain, 6397; total connected, 38,628. Wisconsin Company, net gain, 3157; total connected, 18,851. Total—Net gain, 19,891; total connected, 126,455.

CANADIAN PACIFIC TELEGRAPH.—Messrs. James Kent and B. S. Jenkins, of the Canadian Pacific Telegraph have completed a tour of inspection covering the whole line to the western coast, and including an examination of the British Columbia system throughout the Kootenay and along to Victoria. "When this season's work is finished," states Mr. Kent, "we will have a new line between Laggan and Fort William. We have been doing so many miles each year, and now we have completed that distance, besides accomplishing several hundred miles of renewals on the Pacific division. Additional wire facilities to the extent of 1000 miles will be provided this year."

WEST PENN, PA.—The West Penn Long Distance Telephone Company secured its charter yesterday at Harrisburg, with a capital of $10,000. This company controls the interests of the Pittsburg & Allegheny Telephone Company and was organized to operate outside of the county of Allegheny, which is not allowed by the charter of the latter company. A line will be constructed to connect

the new system with the affiliated system of Baltimore, Md. The new charter provides for the extension of the system into the other counties of Pennsylvania. The work will be pushed to a finish and a fight with the Bell Telephone Company will be carried on with vigor. The new company has already exchanges working in many cities of the eastern part of the State. The new exchange of the Pittsburg & Allegheny Telephone Company, on Seventh Avenue, is about completed, and the lines will soon be in operation in the two cities. The directors of the West Penn Company are: Henry A. Parr and Sydney H. Browne, of Baltimore, Md.; Wm. D. Evans. R. W. Spring and W. W. Handy, of Pittsburg.

ELECTRIC LIGHT AND POWER.

DELPHI, IND.—This city has erected a municipal electric light and water works plant.

FARMLAND, IND.—Bids are invited for an electric light plant to be erected in this city.

LAWRENCEBURG, IND.—Plans for an electric light plant for this place have been completed and work of construction will begin at once.

RICHMOND, IND.—Mayor Zimmerman, of this city, announces that bids will now be received for plans for an electric light plant to cost $100,000.

LAPORTE, IND.—The Laporte Electric Company has increased its capital from $75,000 to $150,000. C. H. Truesdell is president and S. J. Kessler is secretary.

OSGOOD, IND.—James B. Nelson, of Indianapolis, has completed the plans and specifications for an electric light plant at this place. The matter is open for bids.

DUNKIRK, IND.—The Dunkirk City Electric Light & Power Company has been incorporated. The capital stock is $18,000. The directors are John H. Brown, K. A. Tracey and M J. Cook.

KIRKWOOD, MO.—The citizens of Kirkwood will have a special election July 21 to decide whether the city shall erect and operate its own electric light plant. It is proposed to build a plant at a cost not to exceed $17,000.

LAWRENCEBURG, IND.—The City Council will receive propositions until Aug. 1 for the construction of an electric light plant for lighting the streets of Lawrenceburg and the adjoining town of Greendale. J. F. Frazer is clerk of the board.

ASHEVILLE, N. C.—After expending about $100,000 on its immense dam at Ivy Creek, 12 miles from Asheville, the North Carolina Electric Power Company has discontinued the work. It is stated, however, that the suspension is only temporary.

SOUTH SAN FRANCISCO, CAL.—The South San Francisco Power & Light Company has been incorporated. Directors: L. Hough, W. Clayton, J. W. Lilienthal, W. J. Martin and W. E. Dennison, all of San Francisco. Capital stock, $50,000; all subscribed.

RICHMOND, IND.—The council has ordered J. B. Nelson, of Indianapolis, consulting engineer, to prepare plans, specifications and estimates for a municipal electric light plant for 3 per cent of the cost of construction. Work on the plant is to begin at once.

DAYTON, KY., which has been struggling for several years with an inadequate lighting service, expects to be better taken care of in the future. A franchise for this purpose has just been let to the Wadsworth Watchcase Company of that city. The company is now figuring on generators and other material.

FORT WAYNE, IND.—The General Construction Company, of Fort Wayne, has been incorporated, with $40,000 capital stock. The purpose is to operate electric light plants, water works and street railway systems. H. M. Geiger, of Fort Wayne, W. H. Watson, of Charlestown, and T. W. Perry, of Jeffersonville, will be in the company.

PITTSBURG, PA.—The municipal electric department is making preparations for placing all the electric wires of the fire and police department underground. Mayor W. J. Diehl has made a beginning by awarding a contract to Booth & Flinn, the local contractors. for putting the wires under the pavement on Forbes Street. The contract amounts to $1,900.

QUEBEC.—The Quebec Government has just concluded the sale, to American capitalists, of two valuable water-powers at Lake St. John for the sum of $15,000. The purchasers bind themselves to expend, within four years, the sum of $4,000,000 upon the erection of pulp and paper mills, power plant, etc., on the spot. The water-powers sold are on the "Grande Descharge."

COLUMBUS, OHIO.—The local municipal lighting plant was closed down a few days ago as being too expensive to operate. The portion of the city which has been lighted by this plant will be taken care of by the Columbus Electric Light Company. The municipal plant cost $68,000 and was operated in connection with the city water works, power being furnished by a water wheel. The City Council will investigate.

SAULT STE. MARIE, ONT.—The ratepayers of Sault Ste. Marie, Ont., have adopted a by-law granting exemption from taxation and certain other concessions to the Lake Superior Power Company, in return for which the company agrees to construct additional works, at a cost of $2,000,000, such works to include an additional water-power canal, a railroad, railway station, wharves and docks, and the building of a street railway.

RIVERSIDE, CALIF.—The city of Riverside, Cal., is receiving bids for a 600-hp, steam-power electric-lighting plant. The specifications call for one 300-kw, three-phase, alternating-current generator, with revolving field. The voltage required is 2300 volts at 50 cycles, 350 r. p. m. At present the city owns a sub-station and distributing lines and purchases its current from the Redlands Electric Power Company. The distance of transmission is 23 miles, and the e. m. f. 10,000 volts. The dry summers of late years have rendered the water supply for power purposes unreliable.

TORONTO, CANADA.—Some time ago the city engineer of Toronto was instructed to prepare an estimate of the cost of constructing buildings and all the necessary plant for the distribution of electric energy in this city. He states that the buildings and plant would cost $950,000, and the cost of installing an arc lighting plant, with a capacity of 1350 lamps, would be $300,000. If the wires were placed underground in the central portion of the city, the cost would be about $510,000. The annual cost of operating the plant with overhead wires would come to about $63 per lamp per annum, or about 17.2 cents per night.

THE ELECTRIC RAILWAY.

ENGLEWOOD, N. J.—The New Jersey & Hudson River Railroad has formally opened its new extension from here to Hackensack.

ST. LOUIS.—A bill has been introduced into the City Council, asking for a franchise for the St. Louis & Illinois Electric Railway Company.

LARCHMONT, N. Y.—A new trolley line is being built from Mamaroneck Station to Larchmont Manor by the Larchmont Horsecar Company. The line is in operation to Rye Beach.

PORT CLINTON, OHIO.—The work of securing the right of way for the Toledo, Tiffin & Sandusky Electric Railway has been practically completed, and the preliminary work will be started at once.

SACRAMENTO, CAL.—The Sacramento Electric, Gas & Railway Company is reconstructing its electric railroad tracks on M Street, between Fifteenth and Twenty-eighth streets, Sacramento, Cal.

COLUMBUS, OHIO.—The National Traction Company has been granted a franchise over the national pike through Madison County. The franchise has been accepted and a forfeit of $3,000 posted.

LA PORTE, IND.—The filing of the articles of incorporation of the La Porte & Michigan City Railroad Company will be followed by the immediate construction of an electric railway between the two towns.

VENICE, ILL.—All connections have been completed and the power turned on the Venice, Granite City & East St. Louis Electric Railway. Cars are now running from Granite City, via Venice, to East St. Louis.

BELLEVILLE, ILL.—A. W. Morris, Samuel Smiley, J. C. Eisenmeyer and H. R. Horier have applied for a franchise to construct and operate an electric railway from East St. Louis to French Village, Lebanon and O'Fallon.

GRAND RAPIDS, OHIO.—A. M. Jordan, representing Cleveland capitalists, is securing the consent of property owners for an electric line between Fremont and Defiance, touching at Bowling Green, Napoleon and Grand Rapids.

SHARON, PA.—The Mahoning County Commissioners have granted a 50-year franchise to the Sharon & Youngstown Street Railway. It will be 20 miles long, and will pass through several small towns between here and Youngstown.

NEW ALBANY, MINN.—The City Council has granted a 40-year franchise to the New Albany Street Railway Company. The only person named is Alexander Hartman, a son of Louis Hartman, receiver of the street car lines now in operation.

BALTIMORE, MD.—A new system of car transfers went into effect last week, whereby transfers will be given at all points where one line crosses another except at termini, and where a passenger could return in the same general direction.

NEWARK, OHIO.—The announcement is made of the sale of the Newark & Granville electric street railroad, including the Newark city lines, to W. S. Wright, president of the Jewett Car Works, of this city, and other capitalists at Wheeling, W. Va.

TERRE HAUTE, IND.—A company of capitalists, including several Boston men, and W. P. Ijams, of Terre Haute, Ind., has secured franchises on five highways leading out of Terre Haute for electric railroad rights of way. The company has a capital stock of $800,000.

DUBUQUE, IA.—The Dubuque street railway and electric light plants have consolidated. The value of the plants of the Dubuque street railway is $25,000; the Home electric line, $150,000, and the Star Electric Lighting Company, $100,000. The capital of the new company will be $500,000.

YOUNGSTOWN, OHIO.—Mr. C. F. Townsend, representing a St. Louis syndicate, is looking over the ground with a view to building a belt line making the circuit of Youngstown, Sharon, Pa., and New Castle, Pa. This is a distinct enterprise from the Youngstown-Sharon road now being projected.

SAN FRANCISCO, CAL.—The Market Street Railway Company's new electric line on Sansome Street, from Bush to Chestnut, is now in successful operation. It fills a long-felt want in the water-front district, and the company may now be said to have a comprehensive street railway system in San Francisco.

ST. LOUIS, MO.—The St. Louis County Transit Company, which was given a franchise to operate an electric road some time ago, has filed an application in the County Court for an extension of time in which to comply with the provisions of the contract. The request was granted, the limit set being Dec. 1, 1900.

AKRON, OHIO.—The Northern Ohio Traction Company, N. R. Steiner, of this city, and W. A. Johnston, of Barberton, have secured the right of way for a fine boulevard, which they propose to build soon between this city and Barberton, a distance of five miles. The centre of the boulevard is to be occupied by a double electric railway track.

PITTSBURG, PA.—The details for the consolidation of the local street railway companies are rapidly progressing, in spite of the opposition by a few of the stockholders of the Consolidated Company. The minority is so insignificant that its protests are considered unimportant, even though they are calling all the machinery of the law to their aid.

SPRINGFIELD, ILL.—The Harvey City & Southern Electric Railroad Company has been incorporated. The capital stock is to be $150,000. The principal office is to be at Macon, Ill. The incorporators and first board of directors are: J. Smith Butrum, Decatur, Ill.; Robert B. Hennigh, Prairie Home, Ill.; Robert H. Woodward, Harold R. Woodcock and John M. Turner, of Macon, Ill.

WARE, MASS.—The Selectmen have voted to grant a location to the Worcester & Hampshire Street Railroad Company for a line which will go to Gilbertsville and West Brookfield, and connect there with the line to North Brookfield. With the completion of the Palmer & Monson line from Forest Lake to Palmer and Ware, there will be a continuous electric line from Palmer to Boston.

ST. LOUIS, MO.—Extensive improvements, to cost from $500,000 to $1,000,000, will be made, it is reported, by the St. Louis & Suburban Railroad system within the next eight months. New machinery is to be installed, either in a new power house or in the old one. It is probable that there will be an entire change in the plant, and a new electrical system put in to supplant the system now in use.

MILWAUKEE, WIS.—The Milwaukee Electric Railway & Light Company has begun an extension of its Greenfield Avenue line southwestward along the Beloit road, and it is supposed that the company will ultimately run along this route to Muskego Lake and vicinity. The extension is made under a franchise granted the Milwaukee & Muskego Lake Electric Railway Company, the stock of which has been purchased by the M. E. R. & L. Company.

PITTSBURG, PA.—The directors of the Consolidated Traction Company have organized and held their first meeting since the recent meeting of the stockholders, but no action was taken toward executing the lease of the property to the Union Traction Company. The board organized as follows: C. L. Magee, president; Joshua Rhodes, vice-president; W. K. Schoepf, general manager; Samuel E. Moore, controller; W. L. Elkins, treasurer; F. H. Steel, secretary. The board authorized Mr. Schoepf, the general manager, to purchase 50 new winter cars at a cost of from $60,000 to $65,000.

COLUMBUS, OHIO.—The Cincinnati, Hamilton & Dayton Traction Company has filed an application with the State Canal Commission for the lease of the entire Miami and Erie Canal from Cincinnati to Toledo, so far as that property may be used for right of way for electric railways. This is the second application for a lease of the whole course of this canal. The Miami Valley Railway Company has applied for the lease of the canal banks from Troy to Dayton and from Piqua to St. Mary's and for the Sidney feeder, while the Southern Ohio Traction Company has applied for the lease of the portion of the canal between lock No. 2, north of Middletown and Franklin. All of the applications are pending.

MILWAUKEE, WIS.—The M. E. R. & L. Company is to start the preliminary work this fall on what is by far the largest enterprise that the company has so far attempted. General Manager John I. Beggs states that the company is to construct an electric line to Chicago, which will be so built and equipped that its cars will equal the rate of speed maintained by the steam railways. The new line will include the rebuilt portion of the present Milwaukee, Racine & Kenosha line, and will branch out west of Racine, cut past the city limits of Kenosha, not running through that city, and probably pass the western limits of Waukegan. The engineering work will probably begin this fall, and in the spring the work on the new road may be commenced, as at that time it is expected iron and other supplies will have dropped considerably below their present high quotations.

THE AUTOMOBILE.

AUTOMOBILE FACTORY IN CHICOPEE.—It is reported that A. H. Overman has secured a lease of the Ames plant in Chicopee, and will manufacture automobiles on a large scale.

AUTOMOBILE PLANT.—It is understood here that P. H. Flint, representing New York capitalists, has secured the Worcester Cycle Company's plant as the basis for an automobile factory.

THE NATIONAL AUTOMOBILE COMPANY, of Philadelphia, Pa., has been incorporated. Capital, $1,500,000. Incorporators: C. McGill, H. Wells, E. Sampson, J. Fisher, F. Turner, all of Martinsburg; W. C. Leonard, attorney, Martinsburg.

CHARLESTON, W. VA.—The Auto-Storage Battery Company, of Jersey City, has been incorporated here. Capital, $5,000,000. Incorporators: W. B. Smith, F. H. McCoun, C. O'Shaughnessy, L. J. McCormack, all of New York City; C. W. Tonne, attorney, New York.

THE MONTREAL AUTOMOBILE COMPANY is applying for a charter from the Dominion Government. The members of the company are the Hon. T. Berthiaume and Messrs. H. Lamontague, F. Lapointe, Emile Lapage, J. W. Faucher, R. L. De Martigny, Louis Bolduc and Arthur Guimond. The capital is $250,000.

NEW INDUSTRIAL COMPANIES.

THE KINCAID ELECTRICAL COMPANY, of Denver, Colo., has been incorporated. Capital, $45,000. Incorporators: E. E. Baty, F. T. Armbruster, J. A. Kincaid, all of Denver.

COLUMBUS, OHIO.—The Ben Franklin Electric Company, of Zanesville, has been incorporated. Capital, $10,000. Incorporators: J. Shaw, W. W. Harper, S. A. Weller, W. Bailey, G. C. Fergus, R. B. Reed.

THE GENERAL ELECTRICAL REPAIR COMPANY has been organized in Chicago to manufacture and repair electrical apparatus. Capital, $2,400. Incorporators: M. Dahl, R. W. Poelma, F. H. Wheeler, all of Chicago.

THE AUTOMATIC ELECTRIC FIRE ALARM COMPANY has been incorporated in St. Louis, Mo. The capital stock is $100,000. John W. Baker, Hugo F. Koch, Charles P. Johnson, John W. Harris and M. K. McGrath are the incorporators.

GILBERT, WILKES & COMPANY have organized in Denver, Colo., to do a general electrical and mechanical engineering business. Capital, $25,000. Incorporators: G. Wilkes, W. Van R. Wentall, H. L. Woolfender, W. P. Steven, E. Denly, all of Denver.

THE SPRINGFIELD SUBMARINE ELECTRIC LIGHT & CAMERA COMPANY is being organized in Springfield, Mass., with a capital of $500,000, to make a device for photographing under water, which is claimed to be of great value in naval operations and in deep sea construction.

LEGAL.

THE COLUMBIA INCANDESCENT LAMP COMPANY, D. E. Garrison, D. O. Garrison and others, filed suit last week against W. S. Rex, George P. Rex and others to restrain them from interfering with the officers of the company.

INCANDESCENT-LAMP PATENTS.—Judge Shipman, of the United States Circuit Court, has handed down an opinion, in which he held that the Anchor Electric Company had infringed an incandescent-lamp patent owned by the General Electric Company. An accounting of profits is ordered.

MOTOR-SWITCH INTERLOCK CASE.—Judge Shipman, in the United States Circuit Court, New York, on July 18, handed down an opinion in the case of the Thomson-Houston Electric Company vs. Lorain Steel Company, alleging infringement by the defendant of the Knight patent, No. 428,169, for an improved electric motor regulator. The opinion is in favor of the plaintiff, and grants an injunction and an accounting.

OBITUARY.

WINTHROP THAYER, of Boston, Mass., died in that city on July 19, at the age of 37 years. Mr. Thayer, who was well known among electrical and steam engineers throughout the country, was president of the firm of Thayer & Company, steam boiler builders, Boston. He was prominent in social and yachting circles in Boston and was a member of several clubs and scientific societies.

ALEXANDER R. PIKE, manager of the San Francisco office of the Columbia Incandescent Lamp Company, and the Wagner Electric Manufacturing Company, St. Louis, Mo., died suddenly at San Francisco, Saturday, July 14, at the age of 29 years. He was born at Brookline, Mass., and attended the Massachusetts Institute of Technology, entering the electrical field in 1890. He was superintendent of the testing department of the Missouri Edison Company until the fall of 1896, when he resigned to enter the commercial side of the electrical business. He was very widely known among the electrical fraternity, and was a man of sterling quality and ability, and a host of friends will mourn his demise.

WALTER TENNEY CARLETON.—The death of Walter Tenney Carleton, for the past three years the Western Electric Company's representative in Japan, occurred at Haverhill, Mass., on July 6, 1900. His health for a year past had not been good, but on his return to this country in June he had expected that he would be able, after a brief vacation, to take up the work that had been assigned to him at the Chicago house. His death occurred after three days' illness from peritonitis following an unusually difficult operation for appendicitis. Mr. Carleton was 32 years of age, and had been in the company's service over eight years. He graduated from Dartmouth College in 1891, and began work with the company at New York in the following spring. Most of his work here had been in connection with the telephone sales, and he had a large acquaintance among telephone men in the East. In 1897 he went to Japan to look after the company's interests there, and he took a leading part in the organization of the Nippon Electric Company, of Tokyo, being its first secretary. He was devoted to Western Electric interests, and his work was always efficient and successful. A widow and infant son survive him.

PERSONAL.

MR. JOSEPH C. McCALL has resigned the secretaryship of the Electric Company of America, owing to the pressure of his duties as president of the Philadelphia Electric Company.

MR. D. H. LOUDERBACK has resigned the presidency of the Northwestern and Lake Street Elevated Railroads in Chicago, and has been succeeded by L. S. Owsley and Howard Abel, who have been appointed presidents of the Northwestern and Lake Street roads, respectively.

MR. J. B. FULLER.—To the later generation the name of J. B. Fuller may not be very well known, but it was familiar in the early days of the dynamo in this country. Mr. Fuller died in 1879, just under 50 years of age. Educated as a civil engineer, he soon turned to mechanical invention and devised flax-working machinery, taking out some 60 patents. He then became connected with the Western Union Telegraph Company, devising telegraph apparatus, and next, as early as 1874, became interested in the development of electric lighting. In this line, his inventions came in quick succession, and the Fuller and Fuller-Wood dynamos even to-day are among the best-known of their time and class. He also did much to develop electroplating, and at the time of his death was said to be working on alternating-curent systems of lighting with transformers. It will grieve many who remember him, or who appreciate good pioneer work, to learn that his widow and daughter are now in reduced circumstances in New York. Some of their friends are raising a fund in their behalf, to which Mr. Edward Weston has contributed $25 and Mr. T. A. Edison, $10. Any further sums will be gladly received and can be sent to the editor of the ELECTRICAL WORLD AND ENGINEER, and will be duly acknowledged in behalf of the committee, which consists of Prof. R. Ogden Doremus and Mr. Weston, who have kindly allowed the use of their names for this purpose.

THE LATE J. B. FULLER.

Trade Notes.

BANKRUPTCY.—Mr. William R. Mason, of St. Louis, Mo., has filed a petition in involuntary bankruptcy. Mr. Mason's principal creditors are in Chicago.

THE LAWTON-BEATTIE COMPANY, of Cincinnati, has secured the contract for putting in an incandescent system for the Hillsboro Ice Company at Hillsboro, Ohio.

OIL FILTERS FOR THE NAVY.—The new battleship Kearsarge, just completed, will be equipped with Cross oil filters. The U. S. Navy Yard at San Francisco has also just installed six of these filters.

THE STAR ELECTRIC COMPANY.—Mr. W. S. Smith closed a deal by which he comes into possession of the business of the Star Electric Company, corner of St. Clair and Adams streets, Cleveland, Ohio.

NEW YORK ELECTRIC EQUIPMENT COMPANY.—The annual meeting of the New York Electric Equipment Company was held on July 17. Samuel Insull, Martin J. Insull and Philip H. Klein were elected directors.

RHEOSTATS AND DIMMERS.—The Wirt Electric Company, 1028 Filbert Street, Philadelphia, Pa., is sending out a sheet containing testimonials from some of the users of the Wirt rheostats. Satisfaction with these devices is expressed by all the writers.

OTTAWA ELECTRIC CO.—A new 125-lamp, arc-light machine has been installed in No. 1 power house of the Ottawa Electric Company, Ottawa, Ont., by the Western Electric Company, of Chicago. The machine is of the latest and most modern design.

WESTERN ELECTRIC COMPANY, Chicago, Ill., has issued its May and June bulletins, the May bulletin being on the subject of its series enclosed alternating lighting system, the June bulletin relating to police and fire-alarm apparatus. Both are excellently illustrated, and each subject is treated in a clear and concise manner.

CHLORIDE ACCUMULATORS IN ISOLATED PLANTS.—The application of storage batteries to isolated plants is well illustrated in the last bulletin issued by the Electric Storage Battery Company. The plant of the Arnold Print Works, North Adams, Mass., is described, with cuts showing views of the electrical installation.

CIRCUIT BREAKERS.—F. A. La Roche & Company, Thirteenth and Hudson streets, New York, have recently issued an "Engineers' Edition" of Ideal and Victor circuit breakers, automatic switches and automatic apparatus. These various devices are illustrated in a very clear and artistic manner, and diagrams of circuits facilitate a ready understanding of their operation.

DEAN PUMPS.—Dean Bros. Steam Pump Works, Indianapolis, Ind., have issued a valuable catalogue on the subject of its steam pumps. The catalogue contains lists and illustrations of the parts of pumps, directions for operating pumps and tables of useful information. It is well illustrated, and will, no doubt, be valuable to engineers and others interested in steam pumps.

DRILLING MACHINES.—In an artistically gotten up catalogue of 66 pages, the Bickford Drill & Tool Company, Cincinnati, Ohio, illustrates and briefly describes its drills and other machine tools. The illustrations are of high artistic merit and very clearly executed. Some of the machines shown are driven by electric motors, and each machine is briefly described.

DIRECT-CURRENT MULTIPOLAR MOTORS.—Bulletin No. 35a, just issued by the Bullock Electrical Manufacturing Company, Cincinnati, Ohio, relates to direct-current multipolar motors (type "N"). The construction of these machines is briefly described. This type of motor is applicable to lathes, boring mills, blanking presses, drills, etc. Dimension tables are also given, together with excellnt illustrations.

THE HOLOPHANE GLASS COMPANY, New York, is distributing a pamphlet, entitled "Some Practical Hints on Lights and Illumination." The book is of interest to lighting engineers in general, as it shows the difference between the dispersion of light by the holophane and other globes. The diagrams given are from the results of tests made by Prof. Franklin, of Lehigh University, and others, and are accompanied by much useful information.

THE COLUMBIA ELECTRICAL SUPPLY COMPANY, 93 Liberty Street, New York, in addition to its second-hand machinery department, has gone extensively into the handling of second-hand machine tools, and is offering various tools, such as lathes, engine lathes, planers, shapers, grinders, milling machines, etc.; also oil engines. This departure will certainly appeal to the electrical trade, in which such an enormous number of machine tools are used.

"BANNER."—The demand for the well-known Banner weatherproof wire of the Central Electric Company, Chicago, during the past 30 days is evidence of its popularity, and at the same time indicates more than usual activity in construction work. The Central Company is, however, prepared to take care of all orders for weatherproof and Okonite wires, as well as for all other construction material, promptly, from its large and well-assorted stock.

MILWAUKEE, WIS.—The Julius Andrae & Sons Company has called for a meeting of its creditors for July 17. The company is in financial trouble, and has deemed it unfair to continue business under the present conditions. The liabilities are $106,000. An arrangement will probably be made so that the company can continue business. The company, besides its electrical business, manufactured the "Andrae" bicycle. The company has been doing business for 40 years.

BULLOCK ELECTION.—The directors of the Bullock Electric Company, Cincinnati, Ohio, on July 18, re-elected George Bullock president; J. S. Neave, vice-president; Stephen R. Burton, treasurer, and J. W. Bullock, secretary. President Bullock's annual report showed that the company had done a very large business. Vice-President Neave is booked to leave for Europe the first of next month to conclude negotiations for a large line of new business in England, where the company's teaser equipments have been especially successful.

ELECTRIC-LIGHT CARBONS.—The United States Carbon Company, Cleveland, Ohio, has adopted a unique method of acquainting consumers of carbons and the trade with the merits of its goods. It is sending out to the trade a reply postal card, on which is printed an order blank for samples of carbons. The company agrees to take the samples back if they are not satisfactory to the customer. On the first half of the card is given a price list of the various sizes and styles of carbons.

LUNDELL GENERATORS.—To call attention to its line of Lundell generators, the Sprague Electric Company has issued a special catalogue, in which this type of machine is described in detail. The book is quite a large pamphlet, and contains many excellent cuts of the apparatus and various minor parts. Tables of dimensions are added, so that a complete idea of the generators is obtained. The reading matter is especially good, great attention being paid to describing the electrical, magnetic and mechanical details.

WARNER POLE CHANGER.—This device, which is manufactured by the Warner Electric Company, Muncie, Ind., for the purpose of ringing telephones, is fully illustrated and well described in a neat 46-page pamphlet recently illustrated by that company. The pamphlet also contains diagrams showing the method of connecting the wires in using the Warner pole changer. Seven pages at the back are taken up by various testimonials from users of this pole changer, and all of them refer to the apparatus in a very complimentary manner.

SOMETHING ABOUT STORAGE BATTERIES.—The Franklin H. Kalbfleisch Company, manufacturing chemists, 31 Burling Slip, New York, has issued a 20-page pamphlet, consisting principally of an article on "Storage Batteries, Their Construction and Application," written by Mr. George T. Hanchett. The article includes illustrations of the Chloride, Hatch, Willard and Gould batteries and plates. A cut also shows the Willard automobile battery. At the back of the pamphlet is given a list of the chemicals, etc., manufactured by the Kalbfleisch Company.

EMERSON WEEKLY BULLETINS.—The weekly stock reports of the Emerson Electric Manufacturing Company, St. Louis, Mo., are sent out with faithful regularity. They tell the trade the stock of Emerson desk and ceiling fans on hand each week in the New York warehouse at 136 Liberty Street, and the quantity and kind of motors on the road from the factory, together with the date of shipment from St. Louis. This information is valuable to the trade, and enables customers to tell exactly when their orders may be filled from the New York warehouse.

TELEPHONE CATALOGUE.—The Frank Adam Electric Company, 904 Pine Street, St. Louis, Mo., has just issued an 84-page catalogue of its line of telephone apparatus. This company manufactures telephone switchboards of all sizes and all of the parts thereof; automatic generators for exchange and long-distance use; coal grain microphone transmitters and complete telephone sets for long-distance and interior service; power and hand generators; magnetos, etc., etc. The catalogue is very neatly gotten up and well illustrated, with cuts of the apparatus described.

SWITCHES AND SWITCHBOARDS.—The switches, switchboards and tablet boards manufactured by Eyanson & Armpriester, corner Commerce and Seventh streets, Philadelphia, Pa., have attained a high reputation in the trade through their excellence of design and construction. These goods are illustrated and briefly described in a very attractive pamphlet catalogue just issued by the firm. The first part of the catalogue is devoted to switches of all of the different types and standard sizes, followed by a price list and code words to facilitate ordering by telegraph. The long line of switches manufactured by this house may be appreciated by the fact that the price list alone takes up practically five pages of the catalogue. Distribution boards are next taken up and artistic illustrations of the various types are shown together with illustrations of lugs, connectors, etc. Some very fine illustrations of switchboards are given in the next section of the catalogue. One of the boards was manufactured for controlling the power and lighting system of the electrical fountains at the Crystal Palace, London, England. It is fitted with "Eyanson" double-pole, quick-break switches. Messrs. Eyanson & Armpriester announce that switchboards built by them are now in use in England, France, Italy, Austria, Japan, Hawaii, British Columbia, Canada, Mexico, and in almost every State in the Union. They claim to have the largest plant in the United States devoted exclusively to the manufacture of switches, knife switches and switchboards, and in their long experience they have always insisted on making the one line of highest grade goods, which are classed among the best on the market. All those who are interested in switch work will find it to their advantage to secure a copy of catalogue E, which is the designation of the one above referred to.

EDISON INCANDESCENT LAMPS.—One of the handsomest catalogues ever issued from the press of the General Electric Company is that recently brought out on the subject of Edison incandescent lamps. The General Electric Company has long recognized the importance of presenting its trade literature in the highest artistic manner, and each successive catalogue turned out bears evidence of fine artistic development. The incandescent lamp catalogue contains 110 pages, is bound in heavy cardboard and, being printed on heavy-coated paper, constitutes a good-sized book. In preparing the catalogue the company has endeavored to include information which will enable customers to intelligently select the lamp best suited to particular requirements. The opening section is devoted to the manufacture, selection and proper use of lamps. Descriptions and illustrations of the various types of Edison lamps are given in the pages, and the appended general lamp data will be found very valuable. Some very handsome illustrations are used throughout the pages, the first one being a full-page view of the stairway in the Congressional Library, at Washington, on the newel post of which stands a female figure holding in her uplifted hand a cluster of incandescent lamps. Among the other full-page views are shown the ballroom of the Hotel Waldorf-Astoria, New York, the incandescent street illumination in Chicago, the illumination of the grand court of the Omaha Exposition grounds, besides many other smaller pictures of equally artistic merit. There are also several folding sheets containing half-tone, full-size illustrations of large lamps. The catalogue includes, also, a full description of the life and candle-power of lamps, and takes up, in a very excellent manner, the subject of the relative value of arc and incandescent lighting. The illustrations are of the best examples of incandescent illuminations, selected from the various leading public buildings in the country.

Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED JULY 17, 1900.

[Conducted by William A. Rosenbaum, Patent Atorney, Times Bldg., N. Y.]

653,649. UNDERGROUND ELECTRIC RAILWAYS; C. A. Balph, Pittsburg, Pa. App. filed Sept. 14, 1897. The main conductor is enclosed in a flexible tube and connection between it and a sectional conductor is effected by means of plungers connected with the sectional conductor and passing this the wall of the flexible tube.

653,685. ELECTRIC CUT-OUT; H. P. Maxim, Hartford, Conn. App. filed Jan. 20, 1899. The cut-out comprises a device operated by the amperage of the battery and a device operated by the potential of the battery, said devices coacting to open the circuit upon a fall of the potential below a predetermined minimum while the amperage is normal.

653,698. ELECTRIC SWITCH; J. P. Robb, New York, N. Y. App. filed Jan. 21, 1900. Details of construction.

653,708. HYDRO-ELECTRO-THERAPEUTIC APPARATUS; J. J. Stanger, Ulm, Germany. App. filed April 29, 1899. A stream of liquid vapor is made to carry a current of electricity while it is directed against the body.

653,713. ELECTRIC CLOCK; S. P. Thrasher, New Haven, Conn. App. filed Jan. 13, 1899. A weight is provided which is automatically released by the pendulum so as to fall and give an impulse to the pendulum at each stroke. Means are also provided for cushioning the effect of the impulse.

653,715. APPARATUS FOR ELECTRICALLY TREATING FABRICS FOR WATERPROOFING OR OTHER PURPOSES; J. T. Van Gestel, New York, N. Y. App. filed Nov. 1, 1898. (See Curent News and Notes.)

653,716. PROCESS OF WATERPROOFING FABRICS; J. T. Van Gestel, New York, N. Y. App. filed May 3, 1899. (See Current News and Notes.)

653,721. TELEPHONE TRANSMITTER; J. L. West, Omaha, Neb. App. filed March 8, 1900. Details.

653,725. ELECTRIC MOTOR; D. C. Woodward, Hartford, Conn. App. filed Sept. 6, 1898. This is a switch and rheostat by which various connections can be made and a plurality of series of resistances interposed in the field circuit of the motor successively.

653,730. TELEPHONE TRANSMITTER ARM; J. F. Craven, Pittsburg, Pa. App. filed March 22, 1900. The arm is in two parts insulated from each other and carrying the current from the base to the transmitter, thus avoiding the usual flexible cords.

653,739. PROCESS OF PURIFYING WATER; W. M. Jewell, Chicago, Ill. App. filed May 15, 1891. (See Current News and Notes.)

653,753. ELECTRO-GALVANIC BATTERY; H. J. Brewer, New York, N. Y. App. filed July 7, 1899. The invention has to do with the carbon connection, which consists of two metallic pieces countersunk into the carbon and a bolt for clamping the conductor to said pieces.

653,764. ELECTRO-GALVANIC BATTERY; H. J. Brewer, New York, N. Y. App. filed July 7, 1899. Relates to the shape of the carbon.

653,765. ELECTRO-GALVANIC BATTERY; H. J. Brewer, New York, N. Y. App. filed July 7, 1899. Relates to the manner of supporting the carbon electrode.

653,770. GALVANIC BATTERY; A. Heil, Frankfort-on-the-Main, Germany. App. filed April 9, 1900. A cell having an anode, a cathode and a depolarizing agent, consisting of calomel and carbon mixed with an electrically-indifferent body capable of absorbing hydrochloric acid, said mixture surrounding the cathode.

653,784. SYSTEM OF ELECTRICAL DISTRIBUTION; C. DeW. Anderson, Chicago, Ill. App. filed April 10, 1900. This is a commutating device for making various connections to obtain various transformations of current.

653,785. ELECTRIC ARC LAMP; S. Bergmann, New York, N. Y. App. filed March 18, 1899. Details.

653,806. ELECTRIC METER; C. D. Haskins, Newton, Mass. App. filed May 8, 1899. (See Current News and Notes.)

653,841. ELECTRIC FUSE; T. H. Brady, New Britain, Conn. App. filed Jan. 2, 1900. In order to give notice when a fuse inside of a tube has been destroyed, one end of the fuse is connected with a spring which is located on the outside of the tube and recoils when the fuse breaks.

653,857. ELECTRICAL CONTROLLER; E. H. Wise, Johnstown, Pa. App. filed Jan. 19, 1900. A resistance-coil composed of two electrically-independent coils wound on the same core and insulated from each other, each coil having its terminals separate from those of the other coil and arranged for connection in series or in multiple with terminals of the other coil.

653,875. PROCESS OF MANUFACTURING HOMOGENEOUS MIXTURES FOR FILAMENTS OF INCANDESCENT ELECTRIC LAMPS; Karl Ochs, Berlin, Germany. App. filed Oct. 21, 1898. The process of manufacturing homogeneous glowers for lamp-conductors of the second class designed to burn in the open air, which consists in producing a homogeneous solution of mixtures of metallic salts, thereupon precipitating the corresponding oxids of the metallic salts from the salt solution thereby producing a homogeneous mixture of oxids and thereupon forming said precipitated oxids into a paste with a suitable binder and producing glowers therefrom.

653,879. MOTOR VEHICLE; L. J. Phelps, Melrose, Mass. App. filed May 19, 1900. The weight of the operator exerted upon the seat is utilized to actuate a brake to hold the controller shaft at any position to which it may have been moved.

653,881. MIRROR INDICATOR FOR AMPLIFYING MOVEMENTS OF BODIES; A. Pollak, Buda-Pesth, Austria-Hungary. App. filed Dec. 18, 1899. (See Current News and Notes.)

653,882. SECONDARY BATTERY; A. Reuterdahl, Providence, R. I. App. filed Feb. 12, 1900. Details of the structure of the plate.

653,885. CASING FOR ELECTRIC CAR LIGHTING APPARATUS; W. F. Richards, Buffalo, N. Y. App. filed April 4, 1900. The casing is built around the axle pulley and the dynamo pulley and is made with flexible and extensible walls so that it will accommodate itself to changes in the relative positions of the two pulleys.

653,906. ALTERNATING-CURRENT MOTOR; E. W. Brown, Dayton, Ohio. App. filed Jan. 29, 1900. To start the motor two energizing circuits are required, one of which is composed of comparatively large wire of a higher amount of self-induction and lower amount of resistance than the other circuit, which is composed of fine wire, so that after the motor attains a certain speed the curent is cut off from the fine wire and the motor continues to run satisfactorily.

653,933. ELECTRODE FOR ELECTROLYZING APPARATUS; Réné Moritz, Lille, France. App. filed Nov. 29, 1899. This is a carrier for a pair of electrodes, one of which is in the form of a comb, the carrier having grooves and upper and lower channels for the accommodation of the electrodes and for circulation of the liquids.

653,934. PAGE-PRINTING TELEGRAPH; D. Murray, New York, N. Y. App. filed Nov. 28, 1899. (See page 124.)

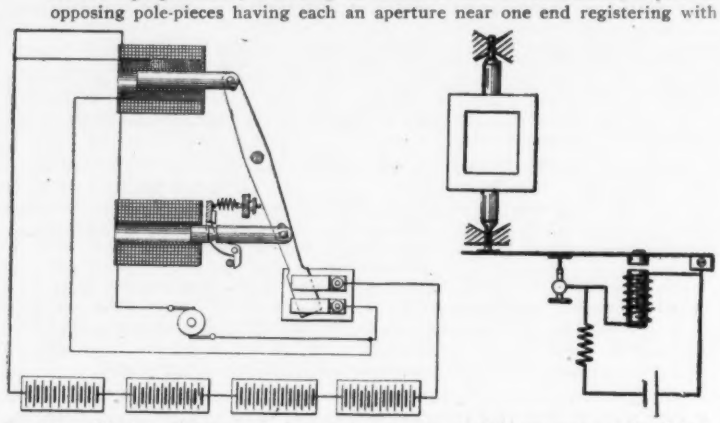
653,935. PAGE-PRINTING TELEGRAPH; D. Murray, New York, N. Y. App. filed Feb. 7, 1900. (See page 124.)

653,936. PAGE-PRINTING TELEGRAPH; D. Murray, New York, N. Y. App. filed Feb. 27, 1900. (See page 124.)

653,941. TELEGRAPH SWITCHING APPARATUS; J. F. Skirrow, East Orange, N. J. App. filed Jan. 5, 1900. The object of this invention is to provide means for throwing out either side of a damaged loop and working a ground return circuit in place thereof, and to make such change of connection mechanically or without the employment of any but the most ordinary skill at the sub-station.

653,945. COMMUTATOR SEGMENT; J. Burke, New York, N. Y. App. filed Jan. 27, 1899. The faces of the segment which abut against each other are formed with interlocking parts arranged to prevent radial displacement.

653,957. MAGNETO-ELECTRIC GENERATOR FOR GAS ENGINE IGNITORS; G. W. Henricks, Indianapolis, Ind. App. filed April 30, 1900. A low voltage generator, including an armature and a commutator, a pair of opposing pole-pieces having each an aperture near one end registering with the commutator, the pole-pieces extending in length, over and beyond the length of the armature and commutator, with the brushes projecting through the apertures in the pole-pieces.



653,685.—Electric Cut-out. 654,103.—Attachment for Instruments of Precision.

653,962. INCANDESCENT LAMP SOCKET; F. H. Manchester and I. E. Brown, Providence, R. I. App. filed May 9, 1900. Details.

653,963. DYNAMO-ELECTRIC MACHINE; W. M. Mordey, London, England. App. filed Oct. 25, 1898. (See Current News and Notes.)

653,984. ELECTRIC ARC LAMP; H. G. Carleton (Carleton Electric Co.), New York, N. Y. App. filed Nov. 7, 1899. A magnet, separate from the main regulating magnet, but in circuit therewith, is used to hold the clutch in engagement with the carbon so that the regulating magnet can operate upon the carbon.

654,050. TROLLEY POLE; C. A. Brown, Lorain, Ohio. App. filed Aug. 22, 1899. When the trolley leaves the wire it automatically releases a latch which permits a spring to draw the pole downward.

654,096. HYGIENIC APPLIANCE FOR SOUND TRANSMITTER MOUTHPIECES; T. R. Owen, Los Angeles, Cal. App. filed Jan. 30, 1900. A strip of paper mounted on a roller can be drawn across the mouthpiece to receive the breath of the user of the telephone. Each person using the instrument can reel off a fresh strip of the paper.

654,103. ATTACHMENT FOR INSTRUMENTS OF PRECISION; C. O. F. Schrottke, Berlin, Germany. App. filed May 15, 1899. To increase the sensitiveness of a rotary shaft or other movable part of an instrument, means are provided for vibrating the shaft in a longitudinal direction, thus overcoming its "Friction of rest."

654,104. MEASURING INSTRUMENT; K. O. F. Schrottke, Berlin, Germany. App. filed Sept. 2, 1899. The object is to provide means for adjusting the relative phase of the current in the shunt field coils of an instrument; this is done by means of a Wheatstone bridge circuit for adjusting the phase of the magnetism due to the field winding of the instrument, the said winding constituting a lateral portion of the bridge.

654,105. ELECTRIC RAILWAY APPLIANCE; D. E. Shoop, Turtle Creek, Pa. App, filed Dec. 9, 1899. The trolley wheel runs above the wire and is divided into two parts, making two separate wheels on the same axis. They are adapted to engage alternately with the upper side of the wire and this shifting facilitates the passing of cross wires.

654,112. TELEPHONE CALL REGISTER; W. Gray, Hartford, Conn. App. filed Sept. 17, 1898. A counting device to be applied to the telephone to register the number of calls.

654,113. BATTERY ELECTRODE; G. Heidel, St. Louis, Mo. App. filed Oct. 2, 1899. Some of the perforations in the plate are occupied by soft rubber plugs extending on both sides of the plate to act as fenders.

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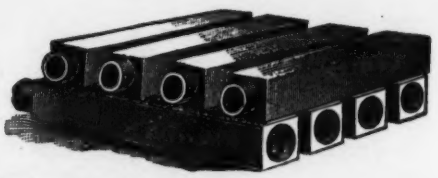

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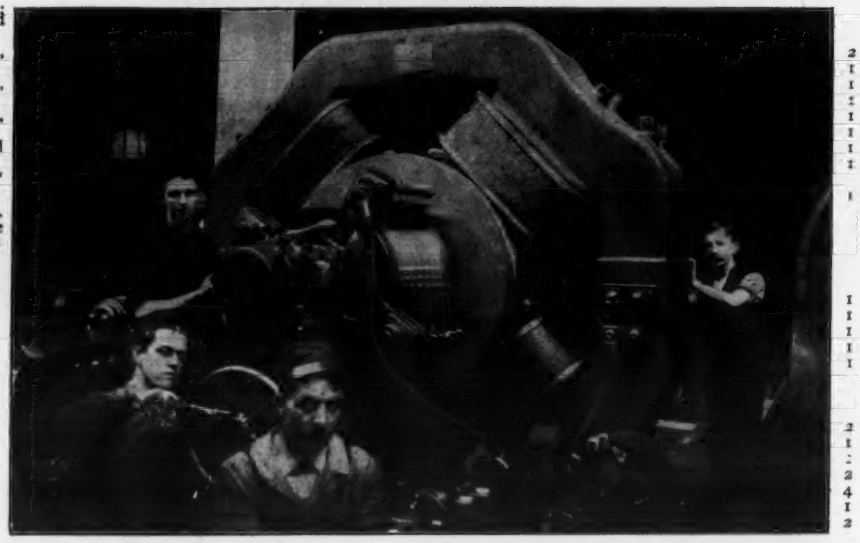
1	50	"	Hawkeye, self-oiler.
1	50	"	Bain, self-oiler.
1	50	"	Card, self-oiler.
1	50	"	Nowotny, self-oiler.
1	50	"	C & C, self-oiler.
1	55	"	Edison, 3 K.W., self-oiler.
1	110	"	Edison, 6 K.W., compound.
1	160	"	Rockford.
1	210	"	Triumph, self-oiler.
1	250	"	Westinghouse, horizontal type.
1	250	"	Commercial, comp., self-oiler.
1	270	"	T.-H., comp., self-oiler.
3	270	"	Westinghouse, M.P., s. s., 15 K.W.
1	340	"	Eddy, self-oiler, compound.
2	350	"	Hawkeye, comp. wound.
1	350	"	National, self-oiler, compound.
1	360	"	Rockford, self-oiler, compound.
1	350	"	Edison, 20 K.W., shunt.
3	350	"	Edison, 20 K.W., self-oilers.
1	350	"	Edison, 20 K.W., self-oiler, compound.
1	400	"	Wood, M.P., s. o., 25 K.W.



VIEW RECONSTRUCTING A GENERATOR, GREGORY ELECTRIC CO.

1	450-light		Edison, 25 K.W., self-oiler.
1	450	"	Rockford, self-oiler.
1	540	"	Edison, 30 K.W.
4	540	"	Edison, 30 K.W., self-oilers.
4	540	"	Edison, 30 K.W., s. o., comp.
1	600	"	Eickmeyer.
1	700	"	Siemens & Halske, 40 K.W., multipolar, slow speed.
2	700	"	Westinghouse, 10-pole, slow speed, 40 K.W., s. o., new.
1	800	"	Rockford, s. o., new arm't.
4	800	"	Edison, 45 K.W., self-oilers.
1	1350-light		Waddell-Enz, 80 K.W., M.P., direct-connected to 125 H.P., self-oiling, 14x14 engine.

220-VOLT GENERATORS.

1	9	K.W.	Lundell, self-oiler.
1	10	"	Lundell, s. o., M.P., s. s.
1	12	"	Eddy, self-oiler, new arm't.
1	12	"	Westinghouse, M.P., self-oiler.
1	25	"	Edison, self-oiler.
1	35	"	E. & C., M.P., slow speed.
1	45	K.W.	Edison, s. o., new arm't, comp.
1	50	"	Westinghouse, s. o., horizontal type, compound.
1	200	"	Crocker-Wheeler, M.P., slow speed, practically new.

BOOSTER SET.

1 Siemens & Halske, 10 K.W., M.P., iron clad type, booster set for raising 27 amp., 26 volts or less. Motor, 90 amp 110 volts, generator, 275 amp., 26 volt mounted on same base.

500-VOLT GENERATORS.

2	15	K.W.	Edison, self-oilers.
1	25	"	T.-H., self-oiler, D25, comp.
1	25	"	Edison, self-oiler.
1	30	"	Jenney, self-oiler.
1	35	"	Jenney, self-oiler, compound.
1	35	"	Mather, self-oiler.
1	45	"	Edison, compound, self-oiler.
1	150	"	Detroit (Rae), M.P., comp., s. o., new armature.
1	100	H.P.,	500-volt Westinghouse, Kodak set Westinghouse generator and Westinghouse comp. engine, 14x24x14, all complete, fine.

ARC DYNAMOS.

1	20-light	2000	C.P.	Western Electric.
1	25	" 2000	"	T.-H., ball arm't.
1	25	" 2000	"	T.-H., ring armature.
1	30	" 2000	"	West. Electric, s. o.
1	30	" 2000	"	Brush, No. 7, with latest improved Steubenrausch commutator.
2	35	" 2000	"	T.-H., LD2.
1	35	" 2000	"	T.-H., ring armature.
1	40	" 2000	"	Wood, No. 7.
2	40	" 2000	"	Western Elec., s. o.
4	45	" 1200	"	T.-H., M12, ball arm.
1	45	" 1200	"	T.-H., M12, ring arm.
2	45	" 1200	"	Brush, No. 7, with latest improved Steubenrausch commutator.
1	50	" 2000	"	Excelsior, latest type, newly rewound field and armature.
2	50	" 1200	"	T.-H., LD12, ball arm.
1	50	" 1200	"	T.-H., LD12, new ring arm't, oil cup.
1	50	" 1200	"	T.-H., LD12, new ring arm't, s. o.
1	50	" 2000	"	T.-H., MD2, s. o., ring armature.
1	50	" 2000	"	West. Elec., s. o.
1	50	" 2000	"	Brush, No. 7½.
2	60	" 2000	"	West. Elec., s. o.

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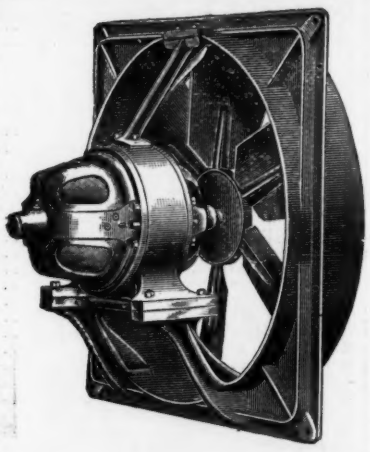

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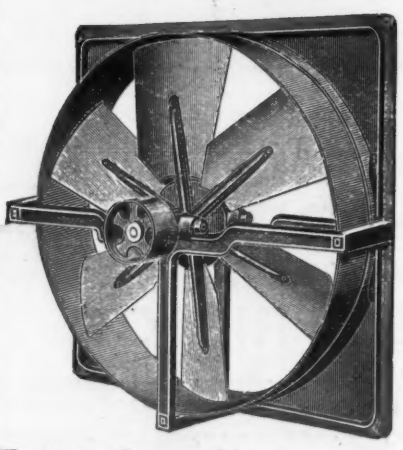

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is the only successful water Desk Fan. Is operated by water pressure of 30 lbs. and upward.

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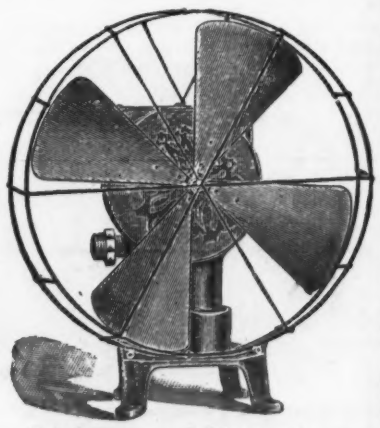

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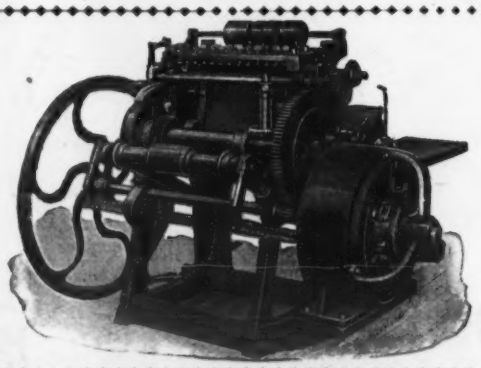

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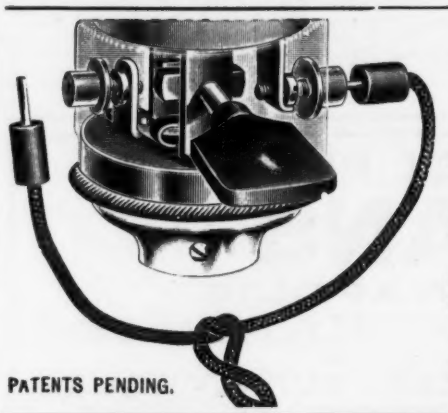

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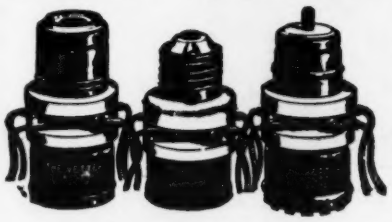

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